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CIRCUIT COURT OF THE UNITED STATES,
FOR THE EASTERN DISTRICT OF PENNSYLVANIA.

LOCOMOTIVE ENGINE SAFETY TRUCK COMPANY <i>vs.</i> THE PENNSYLVANIA RAIL- ROAD COMPANY.	}	In Equity.
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DEFENDANTS' PROOFS ON FINAL ACCOUNTING.

Taken before Robert N. Willson, Esq., Master, appointed by said court to take the proofs and assess the damages.

PHILADELPHIA, April 25th, 1876.

Present : Samuel S. Hollingsworth and Henry B. Renwick, for the complainant ; Chapman Biddle and S. M. Whipple, for the defendant.

ERASTUS O. HILL, a witness produced on behalf of the defendant, is sworn, examined, and says :

Direct examination.

By MR. WHIPPLE :

Question. 1. What is your name, age, residence and occupation ?

Answer. My name you have ; my age is forty-six years ; my residence is at Port Jervis, New York ; my occupation is Superintendent of the Eastern Division of the Erie Railway.

Q. 2. How long have you been Division Superintendent of the Erie Railway ?

A. Three years last January.

Q. 3. How were you employed and by what company before you became Division Superintendent of the Erie Railway?

A. I was employed as General Master Mechanic on the Erie Railway.

Q. 4. For how long a time did you serve in that capacity?

A. From 1869 up to that time, or up to October 1872.

Q. 5. Prior to 1869, how were you engaged and for what company or companies?

A. I was engaged from January 1st, 1869, until November 1st of the same year on the Atlantic and Great Western Road, as General Master Mechanic, and, at that date, I took charge of the Erie and Atlantic and Great Western both, in the same capacity.

Q. 6. Prior to the year 1869, how were you engaged?

A. I was engaged fifteen (15) years on the Lake Shore Road, or Cleveland and Toledo Road as it was then, having since been consolidated as the Lake Shore and Michigan Southern Road.

Q. 7. In what capacity?

A. I went there in 1854 as foreman of the shop, and, about 1861, was appointed Master Mechanic, and served in that capacity until I became connected with the Atlantic and Great Western.

Q. 8. About how many years cover your railroad experience?

A. Thirty (30.)

Q. 9. While you were on the Cleveland and Toledo, now a portion of the Lake Shore and Michigan Southern Railroad, did you have anything to do with swing centre trucks as applied to locomotive engines?

A. We had but one engine, during the time I was there, with that truck, and that being an odd stock we took it out and put in the fixed truck.

Q. 10. After you went on the Atlantic and Great Western Road, did you there come in contact with swing centre trucks as applied to locomotives?

A. I did.

Q. 11. To what extent were they then in use on that road?

A. Well, they were in a majority.

Q. 12. Were your impressions favorable or unfavorable to the swing truck, at first?

(Objected to. Objection sustained.)

Q. 13. Did you, soon after taking charge of the Atlantic and Great Western Railway, have occasion to investigate the comparative merits of the swing centre truck compared with the fixed centre truck as used on that road?

A. No, sir; not particularly on that road.

Q. 14. Did you come to any conclusion on that road as to the comparative value of the two; if so, what was the conclusion?

(Objected to. Objection sustained.)

Q. 15. Did you at any time have occasion to investigate the comparative merits of these two trucks on the Atlantic and Great Western or Erie Railways?

A. I did on the Erie.

Q. 16. Will you state, in brief, the substance of your investigations and the conclusions to which you arrived?

(Objected to.)

By THE MASTER:

Q. 17. What investigation have you made, or what comparison have you made of the two kinds of trucks, swing centre and fixed centre truck?

A. I do not understand just exactly what you have reference to.

By MR. WHIPPLE:

Q. 18. Were you at any time called upon by an officer of the Erie Railway Company to investigate the comparative merits of the two trucks in question and report to him?

A. I was.

Q. 19. Will you now please state the nature of those investigations and the conclusions you arrived at?

A. Well, I spent nearly a month in that investigation, and getting the opinions of the best mechanics known to me in the country, railway mechanics, I made my report in favor of the fixed truck against the swing.

Q. 20. You will please state what facts were brought to your mind that led you to this conclusion. Please state the facts, of your own knowledge, upon which you based the conclusions you arrived at?

A. My attention was first called to look into the merits of the two trucks from the fact that engine No. 71 went down at Basket, killing the fireman. Well, that passed over, and a short time after that, perhaps a year, engine No. 23 went down the bank at Shamung, on the Susquehanna division, from the same cause, killing a man. We began to look into the matter, and we found when we struck that curve, that there was a terrible lurch to the engine, and we attributed the breaking of the wheel to the swing truck. In other words, the forward end of the engine inclined to go into the lot, whereas the truck kept around the curve, throwing the forward pair of drivers hard on the outside of the rail, and the back pair of drivers hard into the inside of the rail instead of their falling into line, as a stationary truck compels them to do.

Q. 21. Did you take into account, in your investigation, the difference in cost of construction of the two trucks?

A. Not at that time; I did afterward.

Q. 22. Please state what you have to say on the matter of the cost of construction, comparing one truck with the other?

A. The cost of construction with us is one hundred dollars (\$100), or about that, in round numbers, in favor of the stationary truck?

Q. 23. That is, it costs in round numbers one hundred dollars (\$100) more to build a swing centre truck than a fixed centre truck?

A. That is the idea.

Q. 24. From your knowledge and observation, how much, per annum, does it require to maintain a swing centre truck compared with a fixed centre truck?

A. About twenty-five (25) per cent. more to maintain the swing than it does the stationary.

Q. 25. How many dollars would you say, per annum?

A. Our records show about twenty-five dollars (\$25) a year

for the swing centre truck for the first four years' running, compared with the fixed truck, nominally nothing. Our road is a six feet gauge road.

Q. 26. At the present time, how many engines are in use by the Erie road having swing centre trucks, and how many fixed centre trucks?

A. I could not answer that question absolutely correct; it would be out of my power to do it.

Q. 27. Approximate, according to your best judgment.

A. I should say two hundred and fifty (250) swing trucks, perhaps more, perhaps not as many.

Q. 28. And how many fixed?

A. About the same number as the other, two hundred and fifty (250) of fixed, and engines that have no trucks.

Q. 29. What is your observation and experience as between the two trucks, as to which is the harder on an engine—the swing centre truck or the fixed centre truck?

A. I consider the swing centre truck the hardest on an engine; that is, the hardest on the truck.

Q. 30. Please give your reasons in brief.

A. For the same reasons that I explained in the other matter; in allowing the forward end of the engine to lurch away from the centre of the track, and thereby placing the drivers at angles across the track, having a tendency to spread them and injure the driving boxes, breaking the frames, and the like of that.

Q. 31. Which truck will enable an engine to obtain the greatest mileage—the fixed centre truck or the swing centre truck, from your knowledge and observation?

A. The fixed centre.

Q. 32. What element, from your experience and judgment, is there in a swing centre truck more favorable than can be found in the fixed centre truck?

A. For a Mogul engine, an engine with three pairs of drivers connected, and a pair of pony pilot wheels, I am a little in favor of the Hudson improvement with radial bars, although a fixed centre will do as well there.

Q. 33. And what do you say as to the remaining engines, comparing the two trucks?

A. The common swing.

Q. 34. Which enables an engine to ride the steadier—a fixed centre or a swing centre truck?

A. The fixed centre; that is my opinion, from observation.

Q. 35. From your knowledge and experience of the use of the two trucks on the Erie Railway, what advantage, if any, is it to the Erie Railway to use a swing centre truck?

A. In my opinion it is a disadvantage, take it as a whole.

Cross-examined.

By MR. HOLLINGSWORTH:

† Q. 36. When were you requested to make this examination of trucks on the Erie Railway?

A. I think it was the 10th of October, 1872; that is my impression now.

† Q. 37. Who made the request?

A. Peter H. Watson, President of the Erie Railway.

† Q. 38. When was the examination made in pursuance of that request?

A. I was at work at that report for him and looking into the matter during the balance of that month.

† Q. 39. When did these accidents occur to those two engines you have spoken of?

A. The dates of that I could not give you here; I have not got the date with me.

† Q. 40. Before or after?

A. Before.

† Q. 41. How long?

A. That I told you I could not give you?

† Q. 42. Within a year?

A. No, sir.

† Q. 43. Five years?

A. Oh, yes, sir.

† Q. 44. When was it then, as near as you can get to it?

A. My impression is that they both occurred in 1871, one in the early part and the other in the latter part, although I will not be positive.

† Q. 45. What kind of truck had these engines under them?

A. Swing truck.

† Q. 46. Bissell's patent?

A. No; Smith's improved swing.

† Q. 47. Which side of the track did they run off?

A. One ran off coming east, went off on the right-hand side; the other went off going west and went off on the left-hand side along the Delaware River.

† Q. 48. Which side of the curve?

A. Outside of the curve. A flange broke on the leading truck-wheel and let them over.

† Q. 49. Please explain what is a leading truck-wheel?

A. The front wheel, the first wheel of the truck (truck-wheels explained by the witness by means of the models).

† Q. 50. Are you sure that the effect of a swing truck upon an engine is to cause a tendency in these drivers to get crosswise of the track?

A. Yes, sir; they cannot help it.

† Q. 51. That is the necessary result of a swing truck on an engine with the Smith improvement?

A. It is the necessary result upon a curve.

† Q. 52. And this result is avoided by the use of a fixed centre-bearing truck?

A. A fixed bearing truck keeps to the centre, right between the two rails. A swing bearing truck goes across the rails so much that we have fixed them so that they are virtually fixed.

† Q. 53. Do you ever take off flanges in the drivers, where you use a centre bearing truck?

A. We do sometimes; we always used to do so.

† Q. 54. Why did they do that?

A. They did it because they had an idea that they could not run two pairs on an engine; I was told that as a boy, but they have been using two pairs of flanges for the last twenty years.

† Q. 55. Do you know the reason?

A. I could not tell.

† Q. 56. Is it not to let the driver swing crosswise on the truck and leave play?

A. Not particularly; it is not necessary.

† Q. 57. Did it not have that effect? Did they not slide that way?

A. No, sir; they do not slide so much with the fixed centre as with the swing.

† Q. 58. When the flanges are off, would not the effect of that be that the drivers would slide laterally on the track?

A. A very little; and so if the flanges were on.

† Q. 59. Do they not do it more than when the flanges are on?

A. No, sir.

† Q. 60. Does it not stop them?

A. It does not; there is an inch of lateral play before they will hit the flanges.

† Q. 61. Do the flanges ever hit the track?

A. They do sometimes, but very slightly. You look over a hundred engines, and you will find scarcely two out of a hundred where the forward flanges are worn, with the fixed truck; but you will always find them worn with the swing.

† Q. 62. Did you not have to turn your tire sooner when using a fixed truck than with a swing truck, of the forward wheel?

A. No, sir.

† Q. 63. Are you certain of it?

A. I have better mileage with the tire of a fixed truck than out of a swing truck.

† Q. 64. Did not you have to turn them?

A. No, sir. I am sure I got better mileage.

† Q. 65. Are you sure?

A. Yes, sir; I have the figures.

† Q. 65½. Are they building any engines now, or making contracts for the supply of engines to the Erie Railway Co. at the present time?

A. Brooks' Locomotive Works are building some at the present time.

† Q. 66. What kind of engines are they ; swing centre or fixed centre trucks ?

A. I could not tell you whether the Smith swing centre trucks or the Jewell patent.

† Q. 67. I ask you whether the engines are fixed centre bearing trucks or swing centre trucks ?

A. Jewell's is, as you might call it, a fixed centre bearing truck or swing truck ; it works on rollers, or cog wheels.

† Q. 68. Does it not swing ?

A. I do not know that it does.

† Q. 69. Is it or is it not a fixed truck ?

A. I have not examined one of Brooks' locomotives that have come there, and I could not tell positively whether the trucks are swing trucks or stationary trucks.

† Q. 70. Do not you know the Erie Railway to have engines with swing trucks ?

A. I certainly do.

† Q. 71. Are you on the Erie Railway ?

A. I am Superintendent, but I have nothing to do with the machinery department.

† Q. 72. Is this Jewell truck what is known as the patented truck of Jewell ?

A. Yes, sir ; it is to take the place of the swing ; my impression is so, although I have not examined one of those engines.

† Q. 73. Did you ever see one of those Jewell trucks on an engine ?

A. Yes, sir.

† Q. 74. Is there any lateral motion on them ?

A. Very little.

† Q. 75. There is some, though ?

A. Yes, sir ; but very little.

† Q. 76. You said there were two hundred and fifty (250) swing trucks and two hundred and fifty (250) without swing trucks, and then there was a certain number of engines other than these that you spoke of.

A. I did not say anything about two hundred and fifty (250)

with fixed centre trucks ; I said two hundred and fifty (250) swing centre trucks.

† Q. 77. How many other ?

A. We have switch engines that have no trucks or drivers, quite a number of them.

† Q. 78. How many, estimating roughly ?

A. I did not come to give numbers exactly ; if I had known you wanted it, I would have given the data perfectly.

† Q. 79. I ask you again how many ?

A. I do not know perfectly ; I am not going to answer questions here which I am not perfect in my own mind are correct ; if I had time I presume I could set them down from my own memory, and count them up.

† Q. 80. Give us the best approximation you can ?

A. I think we have about fifteen (15) that have no trucks at all. We number five hundred and five (505) engines ; some numbers are out of service.

† Q. 81. The rest are either one kind of truck or the other that you have spoken of ?

A. Yes, sir ; mixed.

Signature of deponent waived by consent of counsel.

BENJAMIN W. HEALEY, a witness produced on behalf of defendant, is sworn and examined, and says :

By MR. WHIPPLE :

Question 1. What is your name, age, residence, and occupation ?

Answer. My name is Benjamin W. Healey ; age 50 ; residence, Providence, Rhode Island ; occupation, builder of locomotives.

Q. 2. What experience have you had in building locomotive engines ; please state in full ?

A. It commenced in 1849, at Manchester, New Hampshire. Then on the 1st of January, 1852, I went to Taunton with William Mason, of Taunton, as General Foreman of Construction.

I went from there to Boston for two years and a half as superintendent for the renowned Nat McKay, just at present. From there I went to Providence, in 1869, and I have been there eight years as Superintendent and General Manager of the Rhode Island Locomotive Works.

Q. 3. How many years have you been engaged in the manufacture of locomotive engines?

A. From 1849 to 1876.

Q. 4. Have you had any experience during that time with swing centre trucks as applied to locomotive engines?

A. Yes, sir.

Q. 5. Please state, in brief, the nature of that experience?

A. The first experience was with Mr. Bissell in 1857 or 1858, I think, building a quantity of his trucks for the Fitchburg Railroad in Massachusetts.

Q. 6. At what time did you become acquainted with what is called the Smith swing truck, purporting to be an improvement on the Bissell?

A. I think in 1869, 1871, or 1872, along there.

Q. 7. Please state, in brief, the knowledge you have of the use of swing trucks?

A. Well, I have charge practically on the roads, merely from observation in building and general design for the purposes claimed.

Q. 8. Comparing the fixed centre truck with the swing centre truck, what is your opinion, as an expert, as to the comparative merits of the two?

(Objected to by Mr. Hollingsworth. Objection overruled.)

A. It is in favor of the fixed truck.

Q. 9. And for what reason?

A. For the reason that it costs less, less to maintain, and is better for general use for the engine.

Q. 10. From your experience, what is the difference in the construction of the fixed centre truck compared with the swing centre truck?

A. You mean to say the cost?

Q. 11. Yes, sir.

A. Well, I would make it about fifty dollars (\$50).

Q. 12. What elements are there entering into the swing centre truck that do not enter into the fixed truck, that enables you to arrive at the conclusion that the difference in the cost is fifty dollars (\$50)?

A. The cost of labor and stock.

Q. 13. What parts are there in the swing centre truck that are not in the fixed centre truck?

A. I can hardly explain it by words. There are expenses of different kinds for appliances that are used in the swing centre truck that are not used in the fixed truck.

Q. 14. Which truck, the fixed centre or the swing centre, will carry the engine around a curve with the least power?

A. I consider the fixed truck.

Q. 15. Can you give a reason for that opinion?

A. Simply for the reason that the swing truck leads the engine off in an indirect line, while the fixed truck leads around the curve. Will you allow me to make an explanation?

Q. 16. Certainly?

A. Did you ever see a horse-car driver drive his horses on the outside of a curve in going around it? He always drives on the inside.

Q. 17. Which, in your judgment, requires the most power to propel the engine on a straight or curved track, the swing centre or the fixed centre truck?

A. The swing centre, certainly.

Q. 18. For the reasons already given?

A. Yes, sir.

Cross-examined.

By MR. HOLLINGSWORTH :

† Q. 19. Can you explain why it is that it requires less power to take an engine and its burden, whatever it may be, around a curve, when you use a fixed truck, than when you use a swing truck?

A. Nearly the same that Mr. Hill gives—that the swing allows the drivers to crab; for instance, if you take a single pair of

wheels and put them around a curve, you will find the wheels on the outside of the curve need to be shoved ahead, while the swing truck throws them behind. The operation of the swing truck is contrary to all mathematical theory and practice. The outside front driver has the farthest to go, and consequently it should be shoved ahead instead of being dragged back; whilst the swing truck, when passing off on the outside of the curve, draws that wheel back, which, in vulgar parlance, crabs the engine.

† Q. 20. Is that your only reason?

A. I do not know of another reason. It is contrary to all practical mathematical rules.

† Q. 21. That is substantially your reason?

A. Yes, sir; the thing is practically impossible.

Signature of witness waived by consent of counsel.

HENRY KETTENDORF, a witness produced on behalf of defendant, is sworn and examined, and says:

By MR. WHIPPLE:

Question 1. What is your name, age, residence, and occupation?

Answer. My name is Henry Kettendorf; my age is fifty (50); residence New Haven, Connecticut; occupation, Master Mechanic on the New York, Hartford, and New Haven Railroad.

Q. 2. How long have you been connected with the New York, Hartford and New Haven road?

A. About twenty-eight (28) years.

Q. 2½. In what capacity have you served on that road during these years?

A. I was engineer and machinist first, and for the last ten (10) years master mechanic.

Q. 3. Do you mean locomotive engineer?

A. Yes, sir.

Q. 3½. Then you have run all kinds of locomotives on the New York, Hartford, and New Haven Railroad during that time?

A. I have in regard to swing centre and fixed centre trucks.

Q. 4. When was your attention first called to the use of swing centre trucks on the New York, Hartford, and New Haven Railroad?

A. I think it was somewhere near 1858 when the first of them was bought; I do not remember the exact year.

Q. 5. Have you used more or less trucks with swing centres under locomotive engines on your road for the last ten (10) years or more?

A. No, sir; we have not. We never had more than ten (10) or twelve (12). I took them out as fast as I could.

Q. 6. Have you had experience enough with swing centre trucks to enable you to arrive at the value of the swing centre truck compared with the fixed centre?

A. Yes, sir; I think I have. I think the swing centre truck is a good deal the hardest on engines.

Q. 7. What leads you to the conclusion that it is harder on an engine than the fixed centre truck?

A. The forward wheels are never steady, and the consequence is that our engines used to break the forward boxes.

Q. 8. Did that lead to the conclusion that it was for the advantage of the company to discard the use of such trucks?

A. It did.

Q. 9. Is there any difference in the original cost of constructing the fixed centre truck compared with the cost of constructing the swing centre truck?

A. Yes, there is some. There may be a difference of some thirty (\$30) or forty dollars (\$40). I have never built any swing centre trucks, so that I do not know much about it.

Q. 10. From your observation and experience with swing centre trucks and fixed centre trucks, how much more does it cost to maintain a swing centre truck than it does a fixed centre truck, per annum?

A. I want to answer that in two ways. The way they are built at present probably it would not amount to more than twenty-five (\$25) or thirty dollars (\$30) a year; but the style we had, I would not take for sixty dollars (\$60). The old style of hangers were short, about four inches long. They used to

have four bolts, one on each end of the hanger; now they use two long bolts which go through with a key on each end, and consequently it is not near so expensive to take care of them. I have seen one of our engines go over the road and come back with three bolts broken and the whole engine lie right down on one side.

Q. 11. Of the two trucks in question which is the hardest on an engine, on all conditions of track?

A. I think the swing centre truck.

Q. 12. For what reason?

A. For the reason that the engine is never steady. The harder the engine runs the more she will wear; whereas, the fixed truck will keep the engine steady right around a curve.

Q. 13. Is this shaking of the engine at the expense of power?

A. I think it is.

Q. 14. You think it will take more power to propel an engine constructed with a swing centre, than it would to propel an engine with a fixed truck?

A. I think so. I have never practically tested it.

Q. 15. From your experience and observation, that is your judgment?

A. Yes, sir; it must be.

Q. 16. Do you use plain drivers on engines of your road?

A. Yes, sir. I guess we have five, six, or seven plain drivers.

Q. 17. Are the engines spoken of in the last question illustrated in "Defendant's Exhibit Fixed Centre Truck?"

A. Yes, sir.

Q. 18. Was there ever a time on your road when you used plain tires wholly on the forward drivers?

A. Yes, sir.

Q. 19. And you are using some at the present time?

A. We are using some yet. The last engine I built was turned out on the first of last month, and has a plain tire forward. Still I built engines before that, that had all flanged tires.

Q. 20. What roads in New England are using engines as a general rule with forward drivers, plain tires, and fixed centre trucks like defendant's exhibit?

A. Well, I do not know as I can answer that question.

Q. 21. So far as your knowledge goes?

A. The majority of them; more or less of them are using them.

Q. 22. You mean with a fixed centre and a plain tire?

A. Yes, sir; more or less of the roads are using those locomotives, although I do not know that any of them has adopted a uniform standard.

Q. 23. Do you know what is used on the Boston and Albany road?

A. No; but I am under the impression that they use a flange-tire altogether.

Q. 24. Will you please state here why you use a flange and why a plain tire?

A. Well, I do not know that I have anything particularly in view, only to test the case. I want to test this question, to see if the flange tire or the flat tire will wear a driving-wheel axle any longer without breaking. Understand me, that is with the double flange. That is why I am speaking the way I do. The question frequently comes up with different parties, and one says that one will wear better, and another says that the other will wear better. We can just as well run with one as with the other, and I want to test it.

Q. 25. Which truck, the fixed centre truck or the swing centre truck, will cause the engine to ride the steadier on the track?

A. O! the fixed centre.

Q. 26. Which is the hardest on the flanges of the wheels, the fixed centre truck or the swing centre truck?

A. The swing centre.

Q. 27. What is your reason for this conclusion?

A. It is the hardest on the whole engine, because the front end of the engine is never still, and the truck does not do the work it ought to.

Cross-examined.

By MR. HOLLINGSWORTH :

† Q. 28. Did you turn the tire on your fixed trucks as fast as you did on your swing trucks?

A. Well, I could not say that I ever noticed any difference, as far as turning the tire was concerned, one truck or the other.

† Q. 29. When the tire is worn to a certain extent, you have to turn it, do you not?

A. We have to turn it; we do that for the benefit of the engine.

† Q. 30. Why is it that you think a swing truck is harder on the flange than a fixed truck?

A. I do not think so much about the flange. The trouble I had was the breaking of the frame on the forward jaw.

† Q. 31. Then, in your opinion, it is not any harder on the flange?

A. I have said that I did not see anything about the flange, but I think it is harder on the frame, and, consequently, if it is harder on the frame, it must be harder on the flange.

† Q. 32. Is it harder on the flange than the fixed truck?

A. Yes, sir.

† Q. 33. Why?

A. Because the forward end is going all the time, wriggling, and the forward end of the box is going to strike the hub of the wheel; whereas, in the fixed centre truck the engine is still all the time.

By THE MASTER :

† Q. 34. How is it in turning a curve?

A. Just the same. The swing truck will turn the engine sideways.

By MR. HOLLINGSWORTH :

† Q. 35. Is the lateral pressure of the flange, in going around

a curve, greater in a swing truck than it is in a fixed truck—I mean the pressure of the rail on the flange?

A. Is it greater—

† Q. 36. On the swing truck than it is on the fixed truck?

A. Yes, sir; I think it is.

† Q. 37. Why?

A. I have just explained it: because the forward end is not still. In the first place, when you strike a curve you would think the engine is going right into the lot, and, when she comes back, the front end must strike the hub.

† Q. 38. If it strikes a curve, the body of the engine looks as if it was going off on the outside?

A. Yes, sir.

† Q. 39. The front drivers are fixed fast to the body of the engine, are they not?

A. No, sir; they have play there.

† Q. 40. There is a slight play there. If the body of the engine looks as if it was going over the side, that way, is not the pressure less than in the body of the engine as it turns around that way on the flange of the front tires?

A. No, sir; I say that the body of the engine is a great deal better off with a fixed truck than with a swing centre truck, and you cannot make it any other way.

† Q. 41. Is that the only reason you have for saying so?

A. Yes, sir; it cannot be otherwise. When an engine with a fixed truck strikes a curve, the truck is going to curve. It cannot help it. The engine with a swing centre truck is not going to curve and has to do it all in the frame or in the boiler, and is going to break either the frame or the boiler, if anything.

By THE MASTER:

† Q. 42. Why is it that the frame of the engine suffers more when it goes around upon a lateral motion with a swing truck, than it does when it goes around rigidly upon a fixed centre truck?

A. Because, in the engine with the fixed centre truck, the motion is made through the trucks, upon which the strain comes;

but, in the swing centre truck the motion is thrown upon the frame of the engine and the strain is there.

† Q. 43. Is that strain in the swing centre truck only upon the engine when it strikes the curve, or does it continue upon the engine all the time that it is going around the curve?

A. It continues all the time that it is going around the curve. You will invariably find that she will go back.

† Q. 44. You claim a superiority of the fixed centre truck over the swing centre truck when the engine strikes the curve. Does that superiority continue as long as the engine remains in the curve?

A. Yes, sir; I say that it continues all through, under the fixed centre, because the front end will be still, but just as soon as the engine strikes the curve with the swing truck, and as long as it continues in the curve, the drivers will wriggle back.

By MR. HOLLINGSWORTH:

† Q. 45. Does it cost more to maintain a whole engine with a swing centre truck than it does to maintain an engine with a fixed centre truck—I mean per annum?

A. Yes, sir.

† Q. 46. How much per year will it cost as an engine, and not as a truck alone?

A. Well, about two hundred dollars (\$200).

† Q. 47. It would cost two hundred dollars (\$200) more a year to run an engine with a swing truck on it than one with a fixed truck?

A. Yes, sir; I am speaking about the ones I had.

† Q. 48. Who built them?

A. Rogers, and Danford, Cooke & Co. Some were built by Rogers, and some by Danford, Cooke & Co.

† Q. 49. Were they built originally as swing truck engines, or were they repaired?

A. No, sir; they were built originally.

† Q. 50. Where did they break?

A. They broke the hanger bolt and the link bolt.

† Q. 51. Where did the engine break the frame work?

A. Right through the forward jaw of the forward driver.

† Q. 52. How many of them ever broke there, to your knowledge?

A. You might as well say all.

† Q. 53. Did you repair them?

A. I did.

† Q. 54. How often did they break?

A. Well they did not break more than once, for I took them out as fast as they came in.

† Q. 55. Then you did not repair them?

A. We did not repair them. We put a fixed centre under them, if that is what you mean.

† Q. 56. Have you any swing centres under them now?

A. I think we have one. I think we have one engine with a swing centre motion under it.

† Q. 57. Did that break?

A. Yes, sir; we repaired it. We have had those engines broken the first day they went out.

† Q. 58. Did they break the second time?

A. Yes, sir.

† Q. 59. Where does your road run from?

A. From Forty-second Street, New York, to Springfield, Mass.

† Q. 60. Which is the sharpest curve in it?

A. I do not know as I can tell you. I do not know what the grades of the curves are. That is out of my line. I never have anything to do with the track at all.

Signature of deponent waived by consent of counsel.

WILLIAM H. HARRISON, a witness produced on behalf of defendant, is sworn and examined, and says:

By MR. WHIPPLE:

Question 1. What is your name, age, residence, and occupation?

Answer. My name is William H. Harrison; I am forty-four

years old ; I live in Cumberland, Maryland ; and I am Assistant Master of Machinery on the Baltimore and Ohio Railroad.

Q. 2. For how many years have you been connected with the Baltimore and Ohio Railroad in other capacities ?

A. I have been in their service going on twenty-two (22) years.

Q. 3. And how have you been employed during that twenty-two (22) years ?

A. I commenced working for them as a journeyman and machinist, and was then promoted to Foreman of the Shops, and from that to Master Mechanic at the shops at Wheeling, where I remained some sixteen (16) years. I was then on the Connellsville road for six or seven months, and then I returned to the position I now occupy on the main line.

Q. 4. During the time that you have been in the service of the Baltimore and Ohio Railroad Company, have you had any experience with swing centre trucks under locomotive engines compared with fixed centre trucks ?

A. My experience has been limited. We have no swing centre trucks on the main line, except under the Consolidation and Mogul engines, and they have only a single pair of pony wheels.

Q. 5. What line operated, by the Baltimore and Ohio Railroad Company, if any, use engines with swing trucks ?

A. The Pittsburgh and Connellsville have them ; the Marietta and Cincinnati Railroad Company, and the Central Ohio Divisions—not on all, but on some of them.

Q. 6. To what extent are they used on the Pittsburgh and Connellsville division ?

A. I think the percentage is very large there of the swing centre truck, but I am not able to say how large.

Q. 7. Nearly or quite all of the engines ?

A. Nearly or quite all of the engines.

Q. 8. Have you been connected with that road as Master Mechanic ?

A. I had charge of that division for seven months.

Q. 9. And during that time did a portion of these swing trucks come especially under your observation?

A. Yes, sir; I had them to attend to.

Q. 10. Have there been any swing trucks used on the main line of the Baltimore and Ohio Railroad?

A. No, sir; they have never been used there.

Q. 11. Are they allowed to run over that line from other roads operated by that company?

A. Well, we do not want to do it. We have run engines over there, with double flange and swing centres, and my attention was first drawn to them, I think, during the war, in 1862 or 1863, when we were hauling a good many engines for the government. We had considerable trouble in getting them through our yards and switches, I know.

Q. 12. Since that time, have the swing centre trucks been entirely discarded on the main line?

A. We bought a lot of engines from the government that had double flanges on them, and we altered them to conform with our standard engine, which has a single flange, blind tire, and a rigid truck.

Q. 13. How does the Defendant's Exhibit "fixed centre truck" represent the passenger engines on your road?

A. It represents the kind of engine we are using, the forward pair of drivers blind, the back ones flanged, and the truck rigid.

Q. 14. From your experience with swing centre trucks on the Connellsville division of the Baltimore and Ohio Railroad, what conclusion have you arrived at as to the comparative merits of the two trucks?

A. I have no figures to show, but my experience there was, that they were very troublesome and costly to maintain, as compared with the rigid truck.

Q. 15. What does it cost the Baltimore and Ohio Railroad to construct a fixed centre truck?

A. Our truck costs three hundred and seventy (\$370) or three hundred and eighty dollars (\$380); I do not remember the figures.

Q. 16. What sum would you have to add to that amount in order to construct a swing truck?

A. Well, it would require what I term the cradle of the truck and the cradle bed.

Q. 17. It would amount to about what sum?

A. Probably fifty (\$50) or sixty dollars (\$60). The cradle bed being of wrought iron forged, and the cradle itself cast iron, with the hangers and bolts, I should judge it would cost probably from fifty (\$50) to sixty dollars (\$60) to put it on to our truck.

By THE MASTER:

Q. 18. What would be the difference if you constructed it so, originally; would it make any difference if you constructed the truck with reference to it?

A. We would have to leave off the top plate. We use a top sheet, three-fourths plate. We would have to leave that off and put the swing on, which we would have to do in case we made any change or alteration from one to the other.

Q. 19. I understand you to mean that the additional cost would be the same whether you altered the present form of trucks into swinging trucks, or whether you constructed a truck from nothing, or, from the original elements, into a swing truck, with that design in view from the start?

A. Well, I think it would be about the same.

By MR. HOLLINGSWORTH:

Q. 20. That is, you mean it would be about fifty (\$50) or sixty dollars (\$60) more?

A. Yes, sir.

By MR. WHIPPLE:

Q. 21. Have you with you a detailed statement of the cost of the construction of the fixed centre truck as made by your company?

A. Yes, sir; I have.

Q. 22. Please state, in substance, what it costs in round numbers to build a fixed truck?

A. These are the figures I have taken from the books of the company at Mount Clair, which were handed me in detail. They amount to three hundred ninety-four and $\frac{99}{100}$ dollars (\$394.99), and I believe those figures to be correct.

By MR. HOLLINGSWORTH :

Q. 23. Do you know anything about that statement at all?

A. I got it, I know, from the clerk who got it from the books.

Q. 24. How do you know he got it from the books?

A. I saw him copying it.

By MR. WHIPPLE:

Q. 25. From your knowledge and experience, what sum do you think should be added to the amount given for building a fixed centre truck, to make a swing centre truck?

A. I do not know that I know the amount.

Q. 26. It is a comparison of the cost of construction of the two trucks; you have stated it already, and I would like to have it here repeated.

A. I said I thought it would take from fifty (\$50) to sixty dollars (\$60) more to build a swing centre truck under our engines, which is an estimate, and not from any figures that I have at all.

Q. 27. Have you a tracing of engine No. 13 of the Baltimore and Ohio Railroad?

A. I have.

Q. 28. Will you produce it and file it as an exhibit in this case?

A. Yes, sir. (Tracing produced, marked "Defendant's Exhibit, Engine No. 13, Robert N. Willson, Master.")

Q. 29. Have you a profile of a certain portion of the main line of the Baltimore and Ohio Railroad?

A. I have.

Q. 30. Will you produce it?

A. (Profile produced, marked "Defendants' Exhibit, 17 Mile Grade, Robert N. Willson, Master.")

Q. 31. Have you a tracing of the curvatures on said seventeen (17) mile grade, and, if so, will you please produce it?

A. I have. (Tracing produced marked, "Defendant's Exhibit, Tunnel Curve, Robert N. Willson, Master.")

Q. 32. Have you, of late, witnessed certain trials of an engine on your road pulled by another engine with a dynamometer car between them?

A. I have.

Q. 33. When, and at what place?

A. At Piedmont on the third division of the Baltimore and Ohio Railroad.

Q. 34. And on what grade?

A. On the seventeen (17) mile grade.

Q. 35. What is the name of the engine hauled in that case?

A. Engine No. 13.

Q. 36. Are the specifications of that engine correctly set forth in exhibit marked Defendant's Exhibit, "engine No. 13?"

A. I think so.

Q. 37. Was said engine and tender accurately weighed before the trial commenced?

A. Yes, sir; they were.

Q. 38. Was there fuel or water on the tender, or was it empty?

A. No, sir; the water was blown out of the boiler and run out of the tank, and the coal unloaded.

Q. 39. And the weight set forth in the said exhibit is the weight of the engine without fuel or water?

A. Yes, sir.

Q. 40. What steps were taken with the engine to prepare it for this trial, in regard to the disconnecting of the cylinders?

A. The main rods were taken off the engine.

Q. 41. Why was it thought best to take off the main rods?

A. They wanted to just have the dead weight of the engine; they did not want to have the cylinders working.

Q. 42. When said engine No. 13, with fixed centre truck under it, was taken up said seventeen (17) mile grade, or rather four (4) miles of it, what was the speed agreed upon first?

A. Twelve (12) miles an hour, at first, as close as we could

conform to that, and, on the second trial, twenty-four (24) miles an hour.

Q. 43. Which truck was first used under the engine, the fixed centre truck or the swing centre truck?

A. The swing centre.

Q. 44. What did the amount taken from the diagram made by the dynamometer indicate as to the difference in hauling the same engine over the same track, in the same time, first having a swing centre truck at twelve (12) miles an hour, and afterwards having a fixed centre truck at twelve (12) miles an hour?

A. The difference in pull was given to me by Mr. Dripps and Mr. Cloud. I kept the time of running. One trial was made at twelve (12) miles an hour, and the other at twenty-four (24) miles, as near as it was possible to have it.

Q. 45. And over what portion of the seventeen (17) mile grade were those trials made, or, in other words, from what mile-post to what mile-post on the Baltimore and Ohio Railroad?

A. Commencing at the two hundred and seventh (207) mile-post and running to the two hundred and eleventh (211) mile-post from Baltimore.

Q. 46. The grades and alignments of said four miles of road, are, as you believe, accurately represented in the foregoing exhibits, are they not?

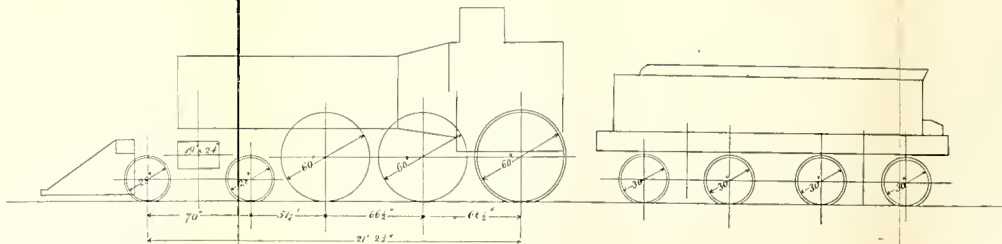
A. They were given to me by the engineer.

Q. 47. Have you an account of mileage of engines as used on the Baltimore and Ohio Railroad, giving the amount of wear before the first turning of the tires?

A. I have a memorandum of the mileage made by some of the engines on the Baltimore and Ohio Railroad.

Q. 48. Will you produce it?

A. Yes, sir. (Memoranda produced, marked "Defendant's Exhibit, Mileage of Engines on B. and O. R. R., No. 1," and "Defendant's Exhibit, Mileage of Engines B. and O. R. R., No. 2,") as follows:



Engine No 13

Wt on Truck	24640 lbs
" " Forward Drivers	10752 "
" " Middle "	18928 "
" " Back "	20160 "
Total Wt of Engine	74480 "
Wt of Tender	28120 "
Total Wt of Engine & Tender	102600 "

W. H. Harrison

Defendants Exhibit -
Engine No. 13.

Robert H. Wilson
Master.



MASTER OF MACHINERY'S OFFICE,
BALTIMORE & OHIO RAILROAD COMPANY.

BALTIMORE, April 20, 1876.

*Statement of Mileage made with Steel Tires, by Engines Nos. 400—
401—402—403—404 and 405.*

Engine.	When put in Service.	Miles run.	Present thickness of Tires.
400	January 30, 1872	130000	$2\frac{3}{16}$ inches.
401	February 13. "	143653	$2\frac{3}{16}$ "
402	" 19. "	147002	$2\frac{3}{16}$ "
403	March 2. "	135707	$2\frac{3}{16}$ "
404	" 18. "	137150	$2\frac{3}{16}$ "
405	" 26. "	137251	$2\frac{3}{16}$ "

The tires of the above engines were of "Butcher's" make.
180.000

W. H. HARRISON.

Defendants Exhibit
Mileage of Engines on
B. & O. R. R. No. 1.

ROBERT N. WILLSON,
Master.

MASTER OF MACHINERY'S OFFICE,
BALTIMORE & OHIO RAILROAD COMPANY.

BALTIMORE, April 21, 1876.

*Statement of Mileage made with Steel Tires by Engines Nos. 318—
320—324—406—407 and 412.*

Engine.	When put in Service.	Miles run.	Present thickness of Tires.
318	May 1. 1872	141 685	2½ inches.
320	June 20. 1872	126778	2½ ₈ “
324	February 18. 1872	127768	2 ⁹ / ₁₆ “
406	May 16. 1873	130657	2½ “
407	“ 24 1873	127.792	2½ ₁₆ “
412	June 28 1873	124.790	2½ ₈ “

The tires on Engines 318—320—324 are Butcher's make.

“ “ “ “ 406—407—412 “ Vickers “

W. H. HARRISON.

Defendants Exhibit

Mileage of Engines on

B. & O. R. R. No. 2.

ROBERT N. WILSON,

Master.

Q. 49. Are the engines named in these exhibits passenger or freight engines?

A. They are passenger engines.

Q. 50. I notice that there are twelve (12) engines, the mileage of which is tabulated here, before turning; is it a fair representation of the mileage of the engines as used on the Baltimore and Ohio Railroad?

A. Yes, sir; these figures I believe to be correct. They are copied right from the records we have at the office.

Q. 51. Please state whether the swing centre truck, as used

on the Pittsburgh and Connellsville road, comes under your immediate observation?

A. It does in this way : it comes into the station at Cumberland over which I have supervision, and I very frequently see and hear reports of complaints about the working of those engines.

Q. 52. While you were directly connected with that road as Master Mechanic, was your connection of such a character as to enable you to determine, in the space of seven (7) months, the comparative value of swing centre and fixed centre trucks?

A. I do not think I was.

Q. 53. Taking the knowledge gained of the swing centre truck on the Pittsburgh and Connellsville road, in connection with experiences you have had of engines on the main line, as you have explained, was that sufficient, or were both together sufficient, to enable you to come to a conclusion as to the comparative merits of the two trucks?

A. I think so in that respect.

By MR. HOLLINGSWORTH:

Q. 54. When you took those engines over your road, during the war, were they fired up, and had they steam on, or were they hauled over?

A. Some of them were brought there under steam, and some were hauled.

Q. 55. How were the most of them?

A. Most of them were hauled.

Q. 56. When an engine is hauled, it is fixed to what is in front of it, is it not?

A. Yes, sir. If an engine is hauled, the draw bar is very short between it and what hauls it.

By MR. WHIPPLE:

Q. 57. Please state, from your knowledge and observation, what is the general effect of the swing centre truck as compared with the fixed centre truck?

A. I think the fixed centre has every advantage over the swing.

Q. 58. Was engine No. 13 pushed up said seventeen (17) mile grade, or a portion thereof, or pulled?

A. It was pulled.

Q. 59. Would pulling be in favor of the swing truck or against it?

A. I believe it would be in favor of it.

Q. 60. In which, in your judgment, would you get the best results, from the engine with fixed truck, and also the same engine with swing centre truck—by pushing or pulling?

A. I believe, if the engine was working herself, pushing, you would get a bigger difference in favor of the rigid truck over the swing centre truck.

Cross-examined.

By MR. HOLLINGSWORTH:

† Q. 61. Where were those grades that you had difficulty with, with those engines, during the war?

A. All the way from Camden Station, through Mount Clair yard, and on any curve almost we came to.

† Q. 62. Between what points?

A. Between Baltimore and Washington.

† Q. 63. Any curve you came to, you had to do what to get around?

A. Well, not on every curve; but, on a great many of them, I had to raise the main wheels up.

† Q. 64. That is, the drivers?

A. Yes, sir; where they were flanged.

† Q. 65. If they had not been flanged, you would have had no difficulty in getting then through, would you?

A. If they had had no flanges and a rigid truck, we could have brought them through perfectly safe.

† Q. 66. And if they all had flanges, and you had not lifted up the wheels, what would have happened?

A. I think they would have run off the track wherever you came to a sharp curve.

† Q. 67. And the way you overcome that difficulty was to raise the front drivers, was it?

A. Yes, sir.

† Q. 68. How is it that any engine with a swing truck stays on the track?

A. We do not use any without blind tires. We have considerable difficulty with our Consolidation engines, where we have four pairs of driving wheels connected, and the swing truck, and a single pair of wheels. Our first pair of driving wheels have blind tires, and the second pair slips in going around a curve. The second pair of flanges would drop off and become very dangerous to the road. In order to escape that we took the flange tire off the second pair of wheels, and the first pair, making a firm, rigid wheel base, and since then we have had no difficulty with them at all.

† Q. 69. How do you account for the engine called "Defendants' Exhibits Swing Truck," with four drivers remaining on the track when it goes around a curve?

A. I do not see why it should. It looks to me like a very dangerous undertaking, and one that I would not suggest to be practicable, and one that I do not believe in.

† Q. 70. You know that a great many of them are used?

A. Yes, sir.

† Q. 71. And in your opinion it is a very dangerous experiment to use them, is it not?

A. Yes, sir.

† Q. 72. You said that the figures on "Defendants' Exhibit, Engine No. 13" correctly represent what they purport to represent?

A. Yes, sir.

† Q. 73. How do you know that?

A. Because I saw them weighed myself.

† Q. 74. And saw the weights put down on the paper?

A. I put the weights down in my book, and gave them to the party who made them, to see that they were correct.

† Q. 75. Did you compare them with the book?

A. Yes, sir.

MR. WHIPPLE. I offer in evidence "Defendants' Exhibit, Engine No. 13," "Defendants' Exhibit, 17 Mile Grade," "Defendants' Exhibit, Tunnel Curve," and "Defendants' Exhibits, Mileage of Engines No. 1 and No. 2."

MR. HOLLINGSWORTH. These are taken subject to objection as to their legal effect.

By MR. HOLLINGSWORTH.

† Q. 76. Do you know, of your own knowledge, that these two exhibits last referred to represent the proper mileage of a fixed truck engine on the Baltimore and Ohio Railroad?

A. We have been using this style of drivers I think between four and five years; I will not be positive about the time. These accounts show the date when the tire was first put in service on the engines, when it required turning, and the number of miles made up to the time they were taken and turned off. That is, engine No. 400, on January 31st, 1872, commenced work and made one hundred and thirty (130) miles, and when the tires were turned off it still left it two inches and two-sixteenths in thickness, the original thickness being three inches.

† Q. 77. Do you know, of your own knowledge, that these two exhibits last referred to represent the proper mileage of a fixed truck engine on the Baltimore and Ohio Railroad?

A. Yes, sir, I do. I believe that these papers are correct. I know that we have not taken exceptional engines, and these figures do represent the general average of our engines.

† Q. 78. How do you know that?

A. From the accounts that are kept at the stations where the tires are put on.

† Q. 79. Did you compare these figures with the result of other engines?

A. Yes, sir.

† Q. 80. With how many?

A. I cannot say with how many, because we get the reports regularly, and the account is kept of them. We have a guarantee given that these tires shall make one hundred and eighty thousand (180,000) miles.

† Q. 81. With the results of how many engines did you compare the results expressed on this paper?

A. The figures that I got from these, I asked the Master of Machinery to give me an account of, where they would compare favorably with the number of steel tires that we had in service. I wanted a fair comparison, and wanted to show the amount of wear. I wanted the highest and the lowest, and these are the figures that he gave me as taken from the reports, condensed from the reports made to the Master of Machinery by the Master Mechanics on the entire line of the road.

† Q. 82. Did you ask him to give you the results of the lowest and greatest mileage?

A. Yes, sir; I told him I wanted that, and those are the figures he furnished me.

† Q. 83. Do you know, of your own knowledge, that they represent the average mileage of the engines on your roads?

A. I suppose they do.

† Q. 84. Have you any other knowledge than what you have expressed, whether they do or not?

A. I have not. I do not keep the run of each and every tire myself, and I have never measured each and every one myself, but I believe that these figures are truthful and correct.

† Q. 85. I do not doubt that; but have you any other means for so saying than what you have stated?

A. I have this means: In going over the road I have this gauge (gauge shown by the witness), and if I see a tire that I think should be turned off, by laying my rule across the face of the tire and running the gauge under it, I can tell how much of the tire is worn, each notch of the gauge being one-sixteenth of an inch.

† Q. 86. And after having done that, you are exactly able to state how much mileage has been made by the engine up to that time, are you?

A. I order the engine to the shop and order the tires turned on the engine, and then the Master Mechanic's duty is to report to the Master of Machinery the date that the engine went into service, the date when it was turned off, and the number of

miles it made between the two times. I have never kept a record of anything.

† Q. 87. And you do not remember any of them?

A. Nothing more than I have on this paper. You want me to say that I keep day and date, and the actual mileage of these engines, which I do not do. That is not possible for me to do, with the number of engines we are using; but we have competent men in charge of the stations whose duty it is to keep the actual mileage of the tires and engines.

† Q. 88. I do not think you quite understand me. What I want to get at is this, you say that even when you go along the road, and you find an engine with its tires worn, you send it in to be repaired, and it then becomes the duty of certain officers to keep a record of the mileage it has made from the time it was put in service to the time it went into the shops to be repaired, and you say you do not remember what the records of these various cases are. Do you say, then, that the paper which you have presented, represents the average mileage of all the engines on the road?

A. The Master of Machinery, Mr. Davis, keeps an account of the mileage made on the entire line of road, and it is from his reports that I got those figures.

† Q. 89. But you do not know any more about whether or not this represents the average mileage of all the engines upon the road, except what the paper itself shows?

A. Yes, sir; I believe that is the average mileage made on the road now.

† Q. 90. But you believe it, because it comes from the office?

A. Well, I have a right to believe that when that is made by competent men.

† Q. 91. But you do believe it for that reason only?

A. What else would I believe it from?

Signature of witness waived by consent of counsel.

Adjourned until to-morrow, Wednesday, April 26th, 1876, at 10 A.M.

PHILADELPHIA, Wednesday, April 26th, 1876.

Parties met, pursuant to adjournment.

Present: For complainant, S. S. Hollingsworth and H. B. Renwick; for defendant, Chapman Biddle and S. M. Whipple.

JOHN H. CARR, a witness produced on behalf of the defendant, is sworn, examined, and says:

By MR. WHIPPLE:

Question 1. What is your name, age, residence, and occupation?

Answer. My name is John H. Carr; my age is forty-three; my residence is Altoona, Pa., and my occupation is having charge of engines that are built and rebuilt in the Pennsylvania Railroad shops, and to see that they are in proper working condition for the road.

Q. 2. You are in the employ of the Pennsylvania Railroad Company, are you not?

A. Yes, sir.

Q. 3. Have you any further duties than those you have named?

A. No, sir; not at present.

Q. 4. Will you specify more particularly what those duties are, and how you perform them?

A. My duties are to look after the engines when they come out of the engine shops, and to see that they are in proper working condition, and run them until I am satisfied that they are in proper working condition, and ready for service upon the road.

Q. 5. You are in some sense responsible for the working of an engine after it passes through your hands?

A. Yes, sir.

Q. 6. How many years experience have you had in connection with railroad machinery, especially of locomotives?

A. Nearly twenty-two (22) years.

Q. 7. In what capacity did you commence service?

A. As a fireman.

Q. 8. How long did you serve in that capacity?

A. I served for awhile at that, for nearly four (4) years.

Q. 9. What position did you occupy thereafter?

A. I was an engineer.

Q. 10. How long were you an engineer before you took your present position?

A. From March, 1855, until November, 1868.

Q. 11. And from that time, you have had charge of engines, as you have already stated?

A. Yes, sir.

Q. 12. About the year 1854, did the Pennsylvania Railroad Company use engines with a plain tire on the forward drivers?

A. They did on the four-wheel connected engines.

Q. 13. On how many?

A. I think on nearly, if not all, in the latter part of 1854 or 1855; they began then to use the flange tire.

Q. 14. That was the year in which they began to use these flange tires?

A. Yes, sir.

Q. 15. What kind of engines do you use at present?

A. All the engines we have at present are flange tires, I believe.

Q. 16. Have you had any experience with what is called the swing centre truck under locomotive engines?

A. I have had experience for the last eight (8) years.

Q. 17. Have you had experience also with fixed centre trucks?

A. Yes, sir.

Q. 18. When did these swing centre trucks first come under your observation?

A. The first observation I had of an engine with a swing centre truck was an engine which I ran in the early part of 1868.

Q. 19. Had the truck been introduced on the road prior to that date?

A. I think there were quite a number of engines previous to that time, but this engine was the first I had a knowledge of.

Q. 20. Had you, previously, run that engine with a fixed centre truck?

A. I had.

Q. 21. And, thereafter, it was changed to a swing centre truck?

A. Yes, sir; it was a swing centre truck after that time.

Q. 22. After running this engine yourself a certain time, what did you observe with reference to the action of this swing centre truck upon the engine?

A. My experience was the difference between that and the time I had run it. My impression and my belief is it is harder on an engine and on the driving boxes. I complained about it very shortly after I got the engine.

Q. 23. In what way was it harder on the driving boxes.

A. Well, it throws them on to a strain in a curve, in every curve, and, as the curve changes, the strain is on one side and then on the other.

Q. 24. Was there anything of what is called "pounding" in the engine, which you think could be justly attributable to the use of the swing centre truck in the engine you ran?

A. I think there was, because the engine boxes got bad in a great deal less time than with the rigid truck.

Q. 25. In which truck is there the most swing of the engine, laterally, in the fixed or swing centre truck?

A. With the swing centre truck, undoubtedly.

Q. 26. Are the boxes any more liable to heat with the swing truck, from your experience, than with the fixed truck?

A. Yes, sir; I think so; I am satisfied of it.

Q. 27. Which truck carries the engine the steadier on all conditions of track, straight and curved?

A. The rigid truck.

Q. 28. What can you say of the repairs on the rigid truck for the first three or four years that the engine is out?

A. Well, I do not think that it requires any repairs except a renewal of a box, or a bolt breaks, or something of that kind.

Q. 29. Are there any repairs connected with the centre arrangement of the truck?

A. Not necessarily, unless something breaks.

Q. 30. What can you say with reference to the swing centre truck?

A. Well, if an engine is run awhile, probably it may have to be renewed, or links and pins put in, at least. I find a good many of them that have been taken out worn in that time.

Q. 31. Is there not a tendency in the swing truck to get the engine, what you call, "out of square"?

A. I think so; yes, sir.

Q. 32. Does that tendency exist in the fixed truck?

A. Not so much.

By THE MASTER:

Q. 33. What do you mean by "out of square"?

A. To get down on one side or the other.

By MR. WHIPPLE:

Q. 34. Lopsided?

A. Yes, sir.

Q. 35. What can you say with regard to the lining of the hubs where fixed trucks are used, as compared with swing trucks?

A. I think it is decidedly in favor of the fixed truck. I mean that it requires less lining to be done to the hubs, driving boxes or wheel centres in the fixed truck.

Q. 36. Please name one advantage that the Pennsylvania Railroad Company has derived from the use of the swing truck that it could not have derived from the use of the fixed truck as applied to a locomotive engine?

A. I cannot name any.

Q. 37. Are you in the habit of running engines up the Altoona grade for the purpose of testing them before delivering them to the company?

A. So far as seeing that they are in good working condition; yes, sir.

Q. 38. You run them empty?

A. Yes, sir; we never give the engine up until we are satisfied that it is fit to do its work; that is to haul a train with it, or to push a train with it, as the case may be.

Q. 39. Am I to understand that you have an estimate as to the amount of coal that would be used by an engine taking itself up the Altoona grade, compared with hauling a load?

A. Nothing more than we notice the difference in the amount of coal.

Q. 40. What would be that difference?

A. I suppose it would be one-fifth to one-quarter of the whole amount of coal consumed. Probably, if you would allow me, I can explain the matter. We generally take an engine out of the shop with about forty bushels of coal. We do not take less than that. I am satisfied, from my own experience, that it takes about one-fourth of the coal to take an engine empty that it does to take an engine loaded, and I am persuaded that I would not undertake to go up the mountain with an empty engine with less than one-fourth of the coal that it would take to carry a loaded engine up.

Cross-examined.

By MR. HOLLINGSWORTH :

† Q. 41. You feel sure that there is no advantage in the swinging truck over the fixed truck, either in safety, or in tires, or in wear of the wheels, or in the locomotives?

A. I do say, that, from all the experience I have had.

† Q. 42. You feel sure of that, do you?

A. I feel confident of that, and have always argued that, at all events.

† Q. 43. Are they using swinging truck engines in the Pennsylvania Railroad now?

A. Yes, sir.

† Q. 44. Are they using them to any extent?

A. A great many of them.

† Q. 45. And the use is increasing daily, is it not, or as fast as they put engines in use, or as they put new engines on?

A. All the engines we build at Altoona have the swinging truck.

† Q. 46. You use the swinging truck on your fast mail train, do you not?

A. Yes, sir.

† Q. 47. And all your passenger engines use the swinging truck, do they not?

A. Yes, sir; all that I know of have the swinging truck.

Signature of deponent waived by consent of counsel.

AMOS C. DAVIS, a witness called on the part of the defendant, is sworn by the uplifted hand, examined, and says :

By MR. WHIPPLE:

Question 1. What is your name, age, residence, and occupation?

Answer. My name is Amos C. Davis; my age is thirty-seven years; my residence is Altoona, Pa.; my occupation is machinist, and at present I am one of the foremen in the erecting department at Altoona.

Q. 2. Do the erecting of engines and repairs of the same come directly under your observation?

A. They do.

Q. 3. How long have you filled that position on the Pennsylvania Railroad, at Altoona?

A. Five years on the 1st of March last.

Q. 4. What has been your experience, as connected with railway machinery, prior to that time?

A. Prior to that, leading back to 1866, I was journeyman, and a small portion of the time fireman on the Pittsburgh division, dating back to 1862; I was in charge of the general repairs of locomotives, and general ordinary repairs. Prior to that I was a journeyman, and a small portion of the time fireman on the Pittsburgh division, dating back to 1862.

Q. 5. Then how long an experience have you had in connection with the construction and repairs of locomotive engines?

A. I have had an experience of fifteen years and over?

Q. 6. Have there come under your observation both fixed centre trucks and swing centre trucks as applied to locomotive engines?

A. There have.

Q. 7. In your inspection of both trucks, as they came in for repairs, have you observed any difference in the wear of the two trucks?

A. I have.

Q. 8. Wherein do they differ?

A. They differ in the wear of links and pins in the swing centre.

Q. 9. Is there any difference in the cost of maintaining one truck, compared with the other, after it is constructed?

A. There certainly is a difference.

Q. 10. What has been your observation as to the repairs in the swing truck compared with the fixed truck?

A. The repairs on the swing centre truck, the pins and links are required to be renewed every twenty or twenty-four months. With the fixed truck we have nothing of that kind to do.

Q. 11. Is the wear ever so great as to wear entirely through the links, and allow the engine to drop upon the under bars?

A. I have had some cases of that kind come under my notice in repairing engines, the links being worn clean through on the top.

Q. 12. What has been your observation in regard to the cost of construction of one truck, compared with the other, so far as the centres go?

A. I have not the figures, but I would say, to the best of my knowledge, there was a difference of fifty dollars or sixty dollars at least, which it would cost to build the swing centre truck over what it would to build the rigid centre truck. It might be more or less.

Q. 13. How many links are in the swing centre truck?

A. Four links.

Q. 14. How many pins?

A. Four pins.

Q. 15. How many keys?

A. Four keys.

Q. 16. And one saddle?

A. One saddle, cast iron.

Q. 17. Those are elements that do not enter into the fixed truck at all?

A. No, sir.

Q. 18. But all are in the swing centre truck?

A. Yes, sir.

Q. 19. What is your experience as to the wear of driving boxes? Are they more worn in the swing than in the fixed truck?

A. They seem so to me. Taking an engine into the shop after running, it seems to have more repairs with a swinging truck than with a fixed truck.

Q. 20. What is your observation in regard to the wear of flanges in an engine with a swing truck and an engine with a fixed truck?

A. I suppose the flanges are worn more with a swing centre truck, especially the front pair.

Q. 21. How are the parallel and main rods of the engine, the brasses thereof, and link rods, affected by the fixed truck compared with the swing truck?

A. Well, I suppose there is a proportion in favor of the rigid centre in regard to the rods, brasses, and crank pins. To my notion there is less wear with a fixed centre on rods and brasses. They seem to last longer, and require less filing, and the pins last longer.

Cross-examined.

By MR. HOLLINGSWORTH :

† Q. 22. Is the wear of a locomotive, taking the whole machine as an entirety, together, greater in the swing truck than it is in the fixed truck?

A. I believe it is.

† Q. 23. Well how much?

A. I am not able to give you the figures.

† Q. 24. Well, what percentage?

A. That is figures.

† Q. 25. Not necessarily, unless you have a basis to start on?

A. I will give you the items as near as I can, and probably you may get the percentage.

† Q. 26. I do not want the items. You say, according to your notion; have you any definite idea on the subject at all.

A. I think I have.

† Q. 27. And with that definite idea, you can give me no other figures or percentage.

A. We have men for that purpose there; I do not keep the record of it.

† Q. 28. You are building engines with swing trucks all the time, are you not?

A. Yes, sir.

† Q. 29. You consider engines with swing trucks inferior in safety to engines with fixed trucks?

A. No, sir; I do not.

† Q. 30. You consider it costs more to maintain an engine with a swing truck than with a fixed truck?

A. I do.

† Q. 31. And costs a little more to build it?

A. Yes, sir.

† Q. 32. Is the capacity of an engine with a swing truck for work more or less than one with a fixed truck?

A. I do not know that; it might possibly be less and possibly it might be greater.

† Q. 33. Costing more to build it and costing more to maintain it, you still continue to build engines with the fixed centre truck?

A. Yes, sir.

† Q. 34. When you say you cannot give me the items for which I ask you, do you mean to say that you cannot give me the items on one particular engine, or on one hundred engines?

A. I can give you the average of that.

† Q. 35. Let us have the average?

A. For instance, we take an engine in for general repairs, with a swing truck, after running two years or twenty months, and we will probably have to turn four or more boxes in that engine, if it is a swing centre truck, and turn the hub of the

wheel, and turn the wedges and liners, or wedges and shoes as we call them.

† Q. 36. What are they ?

A. They fit up into the boxes on the pedestal leg of the engine. The driving box wears in them, and the wear and tear of them is greater in the swing centre than it is in the fixed centre truck. There is more breakage.

† Q. 37. Well how much ?

A. I am giving you the items ; you are to get the percentage. I have noticed more broken flanges on driving boxes, now, than when we were using rigid centres.

† Q. 38. You are through your details ?

A. Unless there is something more which you wish to know that I know.

† Q. 39. Do you run your fast passenger trains faster with a swing truck than you did before you used the swing truck ?

A. Not to the best of my knowledge. I do not think the schedule is any faster than it was when we were using the fixed truck.

† Q. 40. You do not run trains faster then than you did eight years ago ?

A. They may possibly ; I do not think that they do. I am not on the road. I am in the shop.

† Q. 41. Do you run your engines further without stopping them now, than you did some years ago ?

A. Yes, sir ; some of them.

† Q. 42. I mean engines with a swing truck. Do you run engines having swing trucks farther than you did those with fixed trucks which you used ten years ago ?

A. Some of the passenger engines are running farther without stopping.

† Q. 43. Do you answer that question yes or no ?

A. That is the best I can do for it.

By THE MASTER :

† Q. 44. Do you use engines with fixed centre trucks on passenger trains ?

A. I do not know that we do; we may, but if we do it is not to my knowledge.

Signature of deponent waived by consent of counsel.

HUGH D. GARRETT, a witness produced on the part of the defendant, is sworn, examined, and says:

By MR. WHIPPLE:

Question 1. What is your name, age, residence, and occupation?

Answer. My name is Hugh D. Garrett; my age is forty-six years; my residence is West Philadelphia; occupation, Master Mechanic, West Philadelphia shops, Pennsylvania Railroad.

Q. 2. How long have you filled that position?

A. Nine years.

Q. 3. Prior to that time, what road were you engaged with, if any, and for how long?

A. I was engaged with the Lake Shore and old Michigan Southern and Northern Indiana for eight years.

Q. 4. Now a portion of the Lake Shore and Southern Michigan?

A. Yes sir; I had charge of the shops at Laporte, previous to coming on the Pennsylvania road.

Q. 5. What number of years, in all, have you been engaged intimately with the locomotive department of railroads?

A. I commenced in 1849, on the New York Central, it is now; it was then the old Auburn and Rochester road.

Q. 6. During this whole time, you have been wholly identified with railroads and the machinery for operating railroads?

A. Yes, sir; with the exception of about two years during that time.

Q. 7. Have you had any experience with the use of swing centre trucks and fixed centre trucks on the same road, and, if so, where?

A. I had no experience previous to coming on to the Pennsylvania Railroad with swinging centre trucks. It has been

since I have been on the Pennsylvania Railroad that I have had experience with both swinging and rigid trucks.

Q. 8. Both have come under your observation during the whole time that you have been connected with the Pennsylvania Railroad?

A. Yes, sir.

Q. 9. Have you, at any time, been subpoenaed by the complainant in this case now pending before the Master?

A. To the best of my recollection I was subpoenaed; but I do not remember which party subpoenaed me, or which side it was. I know I came to Mr. Willson's office when he was in Walnut street between Seventh and Eighth streets, but I have never given evidence in this case.

Q. 10. Has your attention, at any time, been called to the matter of wearing the flanges of drivers by the use of the different trucks in question?

A. Yes, sir.

Q. 11. Under what circumstances?

A. It was while I was in Mr. Willson's office. At the time there were two gentlemen, I think Master Mechanics from some of the Eastern roads, who were giving their testimony in regard to the matter of the wear of the drivers with the swing centre trucks, and, on my return to the shops, I looked the matter up and compared some twelve (12) engines that were using the rigid centre with twelve that were using the swinging centre.

Q. 12. Have you a tabulated statement of comparison of the said twelve (12) engines with fixed centre trucks with those with swing centres?

A. Yes, sir; this is the statement (statement produced). I got it after my return at that time; I did not carry it any further.

Q. 13. Will you please name the twelve engines with fixed centre trucks, together with the time they went into service and the amount of wear and the mileage on that wear as represented by your tabulated statement?

A. The engines are designated by numbers. The engines having the fixed centre truck were numbers 2, 3, 5, 369, 370, 374, 375, 377, 378, 381, 382, and 383.

Q. 14. Can you give us the dates in reference to those tires?

A. Do you wish each one? It will be a mere repetition of this paper.

Q. 15. I would like to have you state it.

A. The date at which the tires were put in service new? The tires on No. 1 were put in service January 7th, 1868, and the tires on No. 3 were put in service on April 22d, 1868.

Q. 16. Suppose you go on and give us the class of each engine.

By MR. HOLLINGSWORTH:

Q. 17. Are you speaking of your own knowledge of what the engines did?

A. I am, and from the copies of our records.

MR. HOLLINGSWORTH: Then I press an objection, because the witness is not speaking from his own knowledge, but from records.

THE WITNESS: I am speaking from my own knowledge.

By MR. WHIPPLE:

Q. 18. Please state what your means of knowledge are as to the record that you are now called upon to put in evidence?

A. I personally report, weekly, the work done to each and every engine at the shops, after looking over the engines that are taken in for repairs and turned out. I certify the repairs and inspect the work while it is being done, and give orders to the foremen of the different departments in regard to having the work done.

Q. 19. And you also have a record kept of the mileage which each engine performs weekly?

A. Yes, sir; there is a daily record kept of the mileage of each engine, as made.

By THE MASTER:

Q. 20. And to make up this record of the repairs and mileage is a part of your duty is it?

A. Yes, sir; it is my duty to see that there is a correct statement sent weekly to our Superintendent of Motive Power at Altoona, and I do that personally.

Q. 21. And the memorandum which you have here is taken from that record?

A. Yes, sir.

MR. HOLLINGSWORTH: Then I have no objection to the memorandum going in.

The memorandum is as follows:

PENNSYLVANIA RAILROAD COMPANY.

OFFICE OF MASTER MECHANIC,
WEST PHILADELPHIA SHOPS.

WEST PHILADELPHIA, PA., April 25th, 1876.

Statement of mileage and wear of tires of Twelve (12) Freight Engines having the fixed centre truck and Twelve Freight Engines having the swinging centre truck

The Engines using the fixed and swinging centre trucks have the same size cylinders, driving wheels and tires

Statement of Engines having the fixed centre truck

Number of Engine	Date tires were put put in service new	Date of last turning of tires	Wear of Tires	Mileage made
2	Jan. 7, 1868	May 31, 73	15	149 884
3	Apr 22, 1869	Mar 30, 74	8	126 606
5	Jan 1866	Oct 24, 73	12	253 609
369	July 1866	May 14, 72	11	165 522
370	Aug 1866	Nov. . 73	18	196 078
374	Nov. 1866	Jan. 30, 73	19	181.711
375	Nov. 1866	Oct 18, 72	12	174 112
377	Dec. 1866	May 11, 72	12	161.345
378	Dec 1866	Aug 2, 69	9	84 203
381	Dec 1866	July 29, 73	16	196 152
382	Dec 1866	Dec 24, 73	19	209 246
383	Dec 1866	Nov. 71	15	156 562
			166	2055 030

Average miles run per $\frac{1}{16}$ th wear of tires $12379\frac{116}{166}$

H D GARRETT

Statement of Engines having the swing centre truck

Number of Engine	Date tires were put in service new.	Date of last turning of tires	Wear of tires	Mileage made.
423	Sept. 1868	Jan. 15, 1873	8	130 015
424	Oct. 1868	Sept 19, 1874	18	178 601
425	Oct. 1868	Feb 19 1874	14	162 758
426	Nov. 1868	Feb 28, 1873	11	130 137
427	Nov. 1868	Mar 29, 1873	16	135 766
479	June 1870	Jan. 29, 1873	4	87.167
480	June 1870	Aug 31, 1872	3	63 647
482	Dec 1869	Jan 21, 1873	4	68 717
484	Oct. 1871	Feb 28, 1873	4	41 407
485	Oct. 1871	Mar 27, 1873	4	48 294
486	Oct. 1871	Dec 24, 74	5	70 155
490	Oct. 1871	Feb. 19, 73	4	37 926
			95	1154 590

Average miles made pr $\frac{1}{100}$ wear of tires $12.153\frac{55}{99}$. I find $1\frac{82}{100}$ per cent. in favor of the rigid truck.

H D GARRETT

By MR. WHIPPLE:

Q. 22. Will you please state the per cent. of mileage as copied by you in those two records of engines with swing and with fixed centre trucks, in favor of the fixed centre truck, as compared with the swing centre?

A. There is a difference of one and $\frac{82}{100}$ per cent. in favor of the fixed centre.

Q. 23. Have you carefully tabulated this record so that you are able to state that it is an accurate and reliable statement as kept by you, according to the dates therein set forth?

A. I have.

Q. 24. And you have no doubt of its correctness?

A. No doubt whatever.

Q. 25. What principle of selection did you use in determining what engines to compare ; or how did you come to select these special engines ?

A. In making the comparison to get at the wear of tires, to see if there was any actual difference or not, I selected twelve (12) engines built by the Baldwin Locomotive Works, the earliest engines of that class that had come on the road. They were all of the same size and general dimensions, with a fixed centre. Then I selected twelve (12) of the same general dimensions of cylinders and driving-wheels, that had been in the same service with the swinging truck, and compared them in order to see what difference there was. I think there were some three (3) or four (4) of the swinging centre engines that were built at Altoona, but I took the first engines that the Baldwin Locomotive Works turned on the division, with a swinging centre. There was a slight difference in the weight of the two classes of engines, perhaps a thousand (1000) or two thousand (2000) pounds, but they were rated at the same number of cars, drawing the same trains, twenty-two (22) cars on the Philadelphia divisions.

Q. 26. Which were the heavier ?

A. Those having the swing centre were the heaviest. They were of the same dimensions, the same size of driving wheels, the same cylinders and general works, with the exception that of the latter class of engines, may be, a part of them was heavier.

By MR. HOLLINGSWORTH :

Q. 27. What percentage was the additional weight of the swing centre truck over the fixed centre truck ?

A. The fixed centres run about seventy-four thousand (74,000) pounds, and the other run about seventy-six thousand (76,000) pounds.

Q. 28. Were all the engines with the swing centre truck two (2) tons heavier than the other ?

A. I do not know that they were all. I should judge that the difference between the two classes of engines would be about two thousand (2000) pounds. Some of them might be more

than the seventy-four thousand (74,000), and some of them might go over the seventy-six thousand (76,000).

By MR. WHIPPLE:

Q. 29. Were those freight or passenger engines?

A. All freight engines, in the same service.

Q. 30. And what service were they put to?

A. Hauling freight.

Q. 31. And rated at how many ears?

A. Twenty-two (22).

Q. 32. And no more service was performed by the one class than the other?

A. No, sir.

Q. 33. And they ran over the same line of road?

A. Over the same line of road.

Q. 34. And under the same conditions, as far as they could be?

A. Yes, sir; under the same conditions.

Q. 35. Have you made any estimate of the cost of maintaining a swing centre truck compared with the fixed centre truck, per annum, and, if so, what conclusion have you arrived at?

A. The difference between the fixed truck and the swinging centre. I found that we have had to renew the links and pins as often as once in eighteen months. The estimate I made showed a cost of about eleven dollars (\$11) per annum.

Q. 36. Of additional repairs to swing centres over fixed?

A. Yes, sir.

Q. 37. Is there, from your experience, any difference in the cost of constructing the two trucks?

A. There is a difference in the cost of construction.

Q. 38. And about what is that difference?

A. I am not prepared to say about how much it would be. I never kept an accurate account of them because our work was principally repairs.

Q. 39. But you have, particularly, of the cost of maintenance of the two trucks?

A. Yes, sir.

By THE MASTER :

Q. 40. What is the effect of the swing truck as compared with the fixed truck, with reference to the general repairs of locomotives?

A. Taking the entire machine?

Q. 41. Yes, sir.

A. It is a matter that embodies the entire locomotive and it is what the effect would be in the entire machine, as I understand your question.

Q. 42. Yes, sir; or with reference to any particular parts of it, if there is any difference between the two kinds of trucks?

A. The trucks that I have, required these additional repairs over and above the fixed centre truck.

By MR. WHIPPLE :

Q. 43. Or, in other words, which is the easier on an engine, the swing truck or the fixed centre truck, from your general observation and experience?

A. The hubs of the driving wheels have a tendency to cut a little more with the swinging centre than with the fixed centre. I do not think there would be much difference in the cost of maintaining, or the cost of repairs in either case. The truck itself is where it shows the greatest amount of wear and expense in maintaining.

Q. 44. Which will bear the most hard usage under an engine, a fixed centre truck or a swing centre?

A. A fixed centre.

Q. 45. Will you please state one advantage that the Pennsylvania Railroad Company has derived from the use of the swing truck that it could not have derived from the fixed truck?

A. I do not know of any advantage which they have derived from the swing truck.

Cross-examined.

By MR. HOLLINGSWORTH :

† Q. 46. You use swing trucks on the Pennsylvania Railroad to a very large extent, do you not?

A. Yes, sir.

† Q. 47. On all passenger engines?

A. I think they are in use on all passenger engines to my knowledge.

† Q. 48. The Pennsylvania Railroad Company has been, during the last eight (8) years, replacing the fixed centre trucks with swing trucks, have they not?

A. For the last seven (7) or eight (8) years.

† Q. 49. Are they still doing so?

A. Well, the new engines we are receiving have the swing centres.

† Q. 50. They are no cheaper than the fixed centres?

A. No, sir.

† Q. 51. If anything, they cost a little more, do they not?

A. They cost more than the fixed centres.

† Q. 52. And the cost of maintenance is nearly the same?

A. The cost is greater in maintaining the swing centre. There is a renewal of the links and the pins.

Re-examined.

By MR. WHIPPLE:

Q. 53. What is the cost of maintenance of a fixed centre truck compared with a swing centre truck, on the basis of eleven dollars (\$11) a year, as you have already stated in your evidence?

A. The excess of cost would be eleven dollars (\$11) for maintaining a swing centre truck over a fixed centre.

Q. 54. Then, if I understand you, this eleven dollars (\$11) is an excess?

A. That is an excess for a renewal of the links and pins.

Q. 55. Over and above what it would be for the renewal of the truck in the form of a fixed truck?

A. Yes, sir.

Re-cross-examined.

By MR. HOLLINGSWORTH:

† Q. 56. What is the cost of maintaining per annum a fixed truck?

A. It varies very much.

† Q. 57. Give us as near an average as you can. You have given the average difference, the average excess, per annum, of maintaining a swing truck over the fixed truck; give us the average cost of maintaining a swing truck, and the average cost of maintaining a fixed truck?

A. It is in those parts that are not connected with the rigid centre truck.

† Q. 58. Let me get at it. You say that the average cost, per annum, of maintaining a swing centre truck over the rigid truck is eleven dollars (\$11)?

A. Yes, sir.

† Q. 59. What do you take as the average cost of maintaining a fixed truck in reaching that result?

A. I did not take the cost of maintaining the rigid truck into consideration, at all, nor the swing truck, further than the links and pins are concerned.

† Q. 60. On those parts, other than those which you have compared to reach this result of eleven dollars (\$11) a year, is the cost of maintaining a swing truck and a rigid truck the same?

A. I suppose it would be the same renewal of boxes and couplings and brasses and wheels, and all that.

† Q. 61. Do you know whether it is, or not?

A. I know, this far, that these trucks are repaired when they come in, if they need repairing.

† Q. 62. It might be that the operation of one truck was such that while the average cost of maintaining a swing truck would be eleven dollars (\$11), yet, that the construction might make the cost of maintenance less, and therefore I want to get at the fact whether you have compared the whole cost of the maintenance of the two trucks to get at the average difference.

A. In getting at the difference, I just take the additional parts that the swinging centre trucks have over the rigid centres, and I compared just the cost of renewing those.

† Q. 63. That is, you took the annual cost of repairing those parts of the swinging centre trucks which have no existence in the fixed centres?

A. Yes, sir.

† Q. 64. And you did not average the cost of the swinging truck with the fixed truck?

A. No; not the wheels, or anything else.

By MR. WHIPPLE:

† Q. 65. What difference, if any, did you observe in the wearing of wheels, boxes, in one truck or the other, independent of their centres?

A. In the swinging centre trucks I have noticed that the forward pair of wheel flanges cut quicker than they do in the rigid centre truck.

By MR. HOLLINGSWORTH:

† Q. 66. But you have made no comparison of the average cost of maintaining the fixed centre truck, and the swinging centre truck, other than in the points where they differ in construction?

A. No, sir; only where they differ.

By MR. WHIPPLE:

† Q. 67. In your judgment, is there eleven dollars (\$11) difference in maintaining one truck over the other as a whole?

A. Yes, sir.

Signature of deponent waived by consent of counsel.

GEORGE W. STRATTAN, a witness produced on behalf of the defendant is sworn and examined, and says:

By MR. WHIPPLE:

Q. 1. What is your name, age, residence, and occupation?

A. My name is George W. Strattan; I am forty (40) years old; my residence is Altoona, Pennsylvania; and I am occupied now as Master Mechanic of the Locomotive Department at Altoona of the Pennsylvania Railroad Company.

Q. 2. What are your duties?

A. General supervision of the work performed at the Altoona shop.

Q. 3. What work is mostly performed at your shop at Altoona?

A. The building of locomotive engines and repairs to the same.

Q. 4. What further experience have you had in that department other than you have already named?

A. I have been engaged with the Pennsylvania Railroad in the capacity of machinist, and afterward in the office of the Master Mechanic with the exception of eighteen (18) months since March, 1861. Previous to that, I was employed as a machinist in this city.

Q. 5. Does the matter of constructing fixed centre trucks for locomotive engines, and also swing centre trucks, come under your immediate charge?

A. I cannot answer that question directly. I have never had the construction of any fixed centres since I have had charge there.

Q. 6. Have you had of swing centres?

A. Yes, sir.

Q. 7. Have you made a comparison of the cost of the two trucks?

A. I have.

Q. 8. Have you tabulated the items which enter into both?

A. Yes, sir.

Q. 9. Will you produce the same?

A. Yes, sir. (Statement produced as follows.)

Q. 10. According to the calculations set forth in the tabulated statement just handed in, what is the cost of the swing centre truck compared with the cost of the fixed centre truck, or, rather, what is the difference of cost?

A. The difference is twenty-eight dollars and seventy-eight cents (\$28.78).

Q. 11. What is the cost per annum for maintaining that truck?

A. Nine dollars and eighty-two cents (\$9.82) as I figure it. That is the cost of maintaining the swing centre.

Swing Centre above Frame.

	No. of pieces.	Weight.	Price per lb.	Cost of Iron.	Labor Smith Shop.	Labor Machine Shop.	Labor Erecting Shop.	Total cost of Pieces.
Swing Centre.....	1	336lbs	2 cts.	\$6.72	.....	.45	.....	7.17
“ “ Cradle.....	1	225lbs	3 cts.	6.75	9.00	.68	.....	16.43
“ “ Links.....	4	41lbs	“	1.23	1.36	.60	.....	3.19
“ “ Pins.....	4	68lbs	“	2.04	1.36	1.20	.....	4.60
“ “ “ Keys.....	4	1lb	“	.03	.17	.....	.....	.20
Top Braces.....	4	200lbs	“	6.00	2.60	.48	.....	9.08
Bridge Braces.....	2	84lbs	3 cts.	2.52	.75	.48	.....	3.75
Bolts 1 “	20	30lbs	3 cts.	.90	.....	1.04	.....	1.94
Nuts 1 “	20	.....	.....	.....	.....	1.10	.....	1.10
Bolts $\frac{7}{8}$ “	2	.....	.....	.....	.....	.12	.....	.12
Nuts $\frac{7}{8}$ “	2	.....	.....	.....	.....	.08	.....	.08
Bolts $\frac{3}{4}$ “	2	.....	.....	.....	.....	.10	.....	.10
Pipes for Pins.....	2	4 $\frac{1}{4}$ lbs	1 $\frac{1}{2}$ ct	.....	.....	.....	.....	.06
Total.....								\$47.82

Rigid Truck Centre.

Centre Castings.....	2	320lbs	3 cts.	6.40	.....	.24	.....	6.64
Top Braces, Long.....	2	139lbs	3 cts.	4.17	2.40	.24	.....	6.81
“ “ Short.....	2	96lbs	3 cts.	2.88	1.90	.24	.....	5.02
Under “	2	69lbs	3 cts.	2.07	1.40	.18	.....	3.65
								\$22.12

Cost of Truck below frame, \$263.99

Swing Centre attachment, 47.82

Cost of Erecting, 11.90

\$323.71 add 12 per cent. = 362.55

Cost of Truck below frame, \$263.99

Rigid Centre attachment, 22.12

Cost of Erecting, 11.90 \$298.01 add 12 per cent. = 333.77Total Difference, \$25.70 “ “ “ = \$28.78

Cost of Maintenance, Swing centre.

Averages per year, \$8.50 “ “ “ = \$9.52

G. W. STRATTAN

By MR. HOLLINGSWORTH :

Q. 12. And how much for maintaining the fixed centre truck?

A. I have not had an opportunity of figuring any, since I have been in charge.

By MR. WHIPPLE :

Q. 13. What do you mean by your last answer?

A. Maintaining the swinging centre over and above the frame ; independent of the body of the truck.

Q. 14. Have you, of late, witnessed any experiments at Altoona with engines on Altoona grade, so called, with reference to the power required to push an engine up said grade, with the swing truck blocked and unblocked?

A. I have.

Q. 15. Did you take account of the time which was required to perform these experiments or trials?

A. I did.

Q. 16. On what day were those trials made?

A. I will have to refer to my memorandum (referring to memorandum); it was fourth month, 14th day, 1876.

Q. 17. What engine was first used for the purpose of these trials?

A. No. 271.

Q. 18. A freight engine or passenger?

A. A freight engine, having three pairs of drivers.

By MR. HOLLINGSWORTH :

Q. 19. And how many flanges?

A. Two pairs flanged, the middle and back pairs flanged.

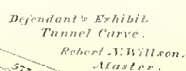
By MR. WHIPPLE :

Q. 20. Have you with you a tracing of engine No. 271?

A. Yes, sir.

Q. 21. Will you produce it and file it as an exhibit in this case?

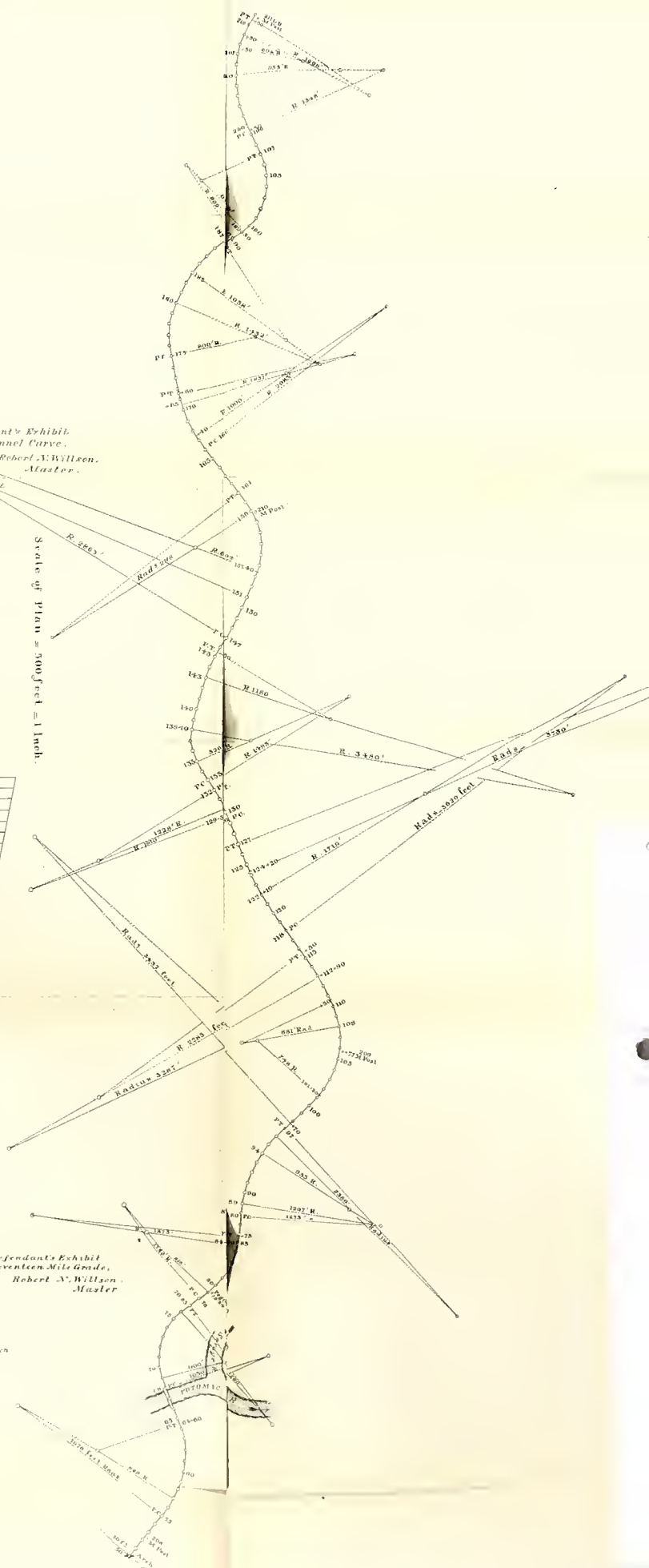
A. Yes, sir. (Tracing produced, marked "Defendants' Exhibit, Engine 271, Robert N. Willson, Master.")



W H Harrison

Scale of Plan = 500 feet = 1 inch

“ Profile, Horiz^l 500 = 1;
 “ Vertical = 50 = 1”





Q. 22. Will you state the specifications of that engine?

A. I will read it from that tracing, if you desire me to.

Q. 23. Are the figures on the tracing correct?

A. Yes, sir; I took these measurements.

Q. 23. What other engine was used in these trials aforesaid?

A. Engine 652.

Q. 27. Passenger or freight?

A. Passenger engine.

Q. 25. Have you also a tracing of said engine, and if so, will you produce it and file it as an exhibit in this case?

A. Yes, sir. (Tracing produced, marked "Defendants' Exhibit, Engine 652, Robert N. Willson, Master.")

Q. 26. Referring to "Defendants' Exhibit, Engine 652," what is the length of wheel base of the drivers?

A. One hundred and two (102) inches.

Q. 27. Is that an unusual length?

A. It is the greatest length between any drivers that are in use on the Pennsylvania Railroad.

Q. 28. You have nothing with a longer base than that in use?

A. No, sir; not between two pairs of wheels. This is like the greatest number of passenger engines we have.

Q. 29. Is it a fair representative of the passenger engines of the Pennsylvania Railroad of that class?

A. Yes, sir; an exact representative.

Q. 30. Take another class of passenger engines, and tell me what is the wheel base of their drivers?

A. Ninety-six (96) inches; six (6) inches less than this.

Q. 31. Have you any other class of passenger engines that has a less base than the one already named?

A. Yes, sir.

By MR. HOLLINGSWORTH:

Q. 32. Engine 652 was built with a swing centre truck?

A. Yes, sir.

By MR. WHIPPLE:

Q. 33. Did you occupy the position of timekeeper during these trials of engines 271 and 652?

A. I did.

Q. 34. Have you tabulated the time which each trial consumed?

A. Yes, sir.

Q. 35. Will you produce it, and file it as part of this case?

A. Yes, sir. (Paper produced as follows.)

Experiments made 4—14—76 with Dynamometer Car No. 2946 and Engines No. 271 and 652, pushing up grade, from Altoona to the 111th mile post, with Engine No. 149.

	ENGINE No. 271.				ENGINE No. 652.			
	With Swing Centre Truck blocked to make rigid Truck		With Swing Centre Truck Free		With Swing Centre Truck blocked to make rigid Truck		With Swing Centre Truck Free.	
	1st Trip	2nd Trip	3rd Trip	4th Trip	1st Trip	2nd Trip	3rd Trip	4th Trip
Culvert	9-21-30	10-21-00	11-48-35	12-35-20	2-50-00	3-40-20	4-24-05	4-59-20
115th mile post	" 45-25	" 44-30	" 52-05	" 39-07	" 58-30	" 43-23	" 26-50	5-02-15
114th " "	" 47-45	" 46-45	" 54-25	" 41-32	3-09-05	" 45-25	" 28-52	" 04-20
113th " "	" 50-10	" 48-55	" 56-40	" 43-50	" 11-12	" 47-30	" 30-53	" 06-17
112th " "	" 52-35	" 51-10	" 59-00	" 46-00	" 13-08	" 49-27	" 32-53	" 08-53
111th " "	" 55-05	" 53-30	12-01-25	" 48-08	" 15-04	" 51-25	" 35-00	" 10-15

Time of running 3 miles, from 114th to 111th mile post

ENG No 271		ENG No 652	
	M. Sec		
1st Trip,	7—20	1st Trip,	5—59
2nd "	6—45	2nd "	6—00
3rd "	7—00	3rd "	6—08
4th "	6—36	4th "	5—55
Genl Average, . . 6—55½		Genl Average, . . 6—00½	

Speed 26 miles per hour

Speed, = 30 miles per hour.

G. W. STRATTAN.

Q. 35. Will you please state what changes, if any, were made in these two engines, before they were deemed suitable to enter upon these trials?

A. With wood, we blocked the swing centre rigidly in the middle of the truck, to represent a rigid centre truck.

Q. 36. Were the main rods disconnected from the cylinders also?

A. The main rods were also disconnected.

Q. 37. For what reason?

A. So that we might not encounter the resistance of the pistons in the cylinders.

Q. 38. Were these engines pushed up Altoona grade or hauled?

A. Pushed up the grade.

Q. 39. Did you keep, accurately, the time from mile-post to mile-post, through all these trials?

A. I did.

Q. 40. And the same is correctly tabulated in the record already in evidence?

A. Yes, sir.

Q. 41. How many engines with swing trucks are now in use on the Pennsylvania Railroad, and also on the United Railroads of New Jersey division?

A. Well, that is contained in a telegram which I received yesterday. I have a memorandum of it which I can read.

Q. 42. I merely want to get at the number of engines having swinging centre trucks, and also having fixed centre trucks on the Pennsylvania Railroad, and also on the United Railroads of New Jersey division?

A. The number of engines on the Pennsylvania division having swing trucks is four hundred and forty-five (445).

Q. 43. And how many are to be added to that on the New Jersey division?

A. Ninety-four (94) on the United Railroads of New Jersey.

Q. 44. Making a total of how many?

A. Five hundred and thirty-nine (539).

Q. 45. How many engines with fixed trucks are there on the two divisions you have named?

A. With fixed trucks on the Pennsylvania Railroad division there are one hundred and forty-one (141).

Q. 46. And on the other?

A. On the United Railroads of New Jersey division one hundred and thirteen (113), making two hundred and forty-five (245).

Cross-examined.

By MR. HOLLINGSWORTH:

† Q. 47. All the passenger engines nearly are swing truck engines on both roads, are they not?

A. I think so. I am not positive about the Jersey roads.

† Q. 48. How about the Pennsylvania road?

A. I think they are built so on the Pennsylvania road; but I do not know about the Jersey divisions.

† Q. 49. There are a certain number of engines on those two roads you say that have fixed trucks, do not you include in that number, engines that have no trucks and are used around depots?

A. I do not.

† Q. 50. That is exclusive of those?

A. That is exclusive of shifting engines, and engines of different construction having no trucks.

† Q. 51. I want to ask you again in regard to those two engines on which these experiments were performed, near Altoona; were those engines built with a swing truck?

A. One was.

† Q. 52. Which one?

A. 652.

† Q. 53. How about the other?

A. It was built at Baldwin's, and I suppose the swing truck was put on when it was built. It must have been put on when it was built. I do not know the history of the engine.

† Q. 54. When you took those engines to make those experiments, they were then adapted to run as swing truck engines, were they not?

A. Yes, sir.

† Q. 55. Who built the engines?

A. No. 652 was built at Altoona, and No. 271 at the Baldwin Locomotive Works.

† Q. 56. And that was rebuilt or altered, you said?

A. Rebuilt at Altoona shop, I presume. It is possible that it might have been rebuilt at Harrisburg, but I think it was at Altoona.

Signature of deponent waived by consent of counsel.

Adjourned until this afternoon at 2 o'clock.

2 P.M.

JOHN W. CLOUD, a witness called by defendants, is sworn, examined, and says:

By MR. BIDDLE:

Question. 1. What is your profession?

Answer. I am at present engaged in looking after all experiments that are made around Altoona shops on locomotives and on materials used in construction, etc.

Q. 2. Were you specially trained for this purpose? Have you received a special education for this purpose?

A. Yes, sir; I have received a scientific education, a collegiate course.

Q. 3. Where was that?

A. That was at Harvard University.

Q. 4. Are you a graduate of that university?

A. I am.

Q. 5. When did you graduate?

A. In the class of 1873.

Q. 6. And into what business did you go when you were graduated at Harvard?

A. I went into the railroad; first, at Williamsport. I was in the transportation department of the Philadelphia and Erie Railroad for a short time. From there I went to Altoona, and was in the office of the Superintendent of Motive Power for six (6) or eight (8) months.

Q. 7. In charge of which branch of that transportation department were you, or are you now?

A. I am in charge of the experiments at Altoona now.

Q. 8. Being in charge of this department of experiments, what are your duties? Give them generally.

A. My duties are to test the materials used in construction, iron and steel and materials used in running a road, as packings, oils, etc.; and to make whatever experiments the company direct made as to the quantity of coal consumed in doing cer-

tain work and general efficiency of locomotive engines, and sometimes stationary engines.

Q. 9. Have you made any experiments in regard to locomotive engines?

A. Yes, sir; experiments in regard to engines, principally with a view to determining the amount of coal burned.

Q. 10. Any other experiments?

A. Yes, sir.

Q. 11. Just state them.

A. I conducted a series of experiments for three weeks to determine the relative value of two (2) engines of different build.

Q. 12. Having been employed, and being employed as you are, do you know what the grade is of any portion of the Altoona division of the road?

A. I do not know what you allude to as the Altoona division?

Q. 13. The grade west of Altoona, including the Horseshoe Curve?

A. That is the east end of the Pittsburgh division. I do not know by having measured it. I only know by talking with engineers who have measured it, and seeing it on the plans in the General Superintendent's office at Altoona.

Q. 14. Have you a copy of these grades with you?

A. I have a copy of a portion of it.

Q. 15. State of what portion you have a copy?

A. I have here profile and alignment of three (3) miles between posts 240 and 243 from Philadelphia.

Q. 16. And about where would that commence? State what would be the 240th mile on the road?

A. The 240th mile-post from Philadelphia is about three miles beyond Altoona.

Q. 17. And the other terminal point?

A. Mile-post two hundred and forty-three (243) is six (6) miles beyond Altoona, and is the first mile-post west of Horseshoe Curve; that is, the last mile includes the curve.

Q. 18. Then am I right in inferring that those three (3) miles include the whole of the Horseshoe Curve?

A. The last mile does; yes, sir.

Q. 19. What are the grades of those three (3) miles commencing at mile-post two hundred and forty (240), and terminating at mile-post two hundred and forty-three (243)?

A. Do you wish me to read the grades?

Q. 20. Yes, sir; I want to know what they are?

A. The two hundred and fortieth (240) mile-post is on a grade of ninety-five and four one-hundredths ($95\frac{4}{100}$) feet to the mile. This tracing does not show the distance from the mile-post to the first change of grade, but I can give you a general idea of it. At eight hundred (800) feet from the mile-post the grade changes to ninety-two and four one-hundredths ($92\frac{4}{100}$) ft. to a mile for one thousand (1000) feet. Then there is a change to ninety-five and four one-hundredths ($95\frac{4}{100}$) to the mile for twelve hundred (1200) feet. Then to eighty-seven and twelve one-hundredths ($87\frac{12}{100}$) for seven hundred (700) feet. Then a change to ninety-five and four one-hundredths ($95\frac{4}{100}$) for one thousand (1000) feet; a change to eighty-four and eight one-hundredths ($84\frac{8}{100}$) for five hundred (500) feet; a change to eighty-eight and seventy one-hundredths ($88\frac{70}{100}$) for three thousand (3000) feet; a change to ninety-five and four one-hundredths ($95\frac{4}{100}$) elevation for thirty-four hundred (3400) feet; a change to sixty-eight and sixty-four one-hundredths ($68\frac{64}{100}$) feet per mile for nine hundred (900) feet; a change to eighty-nine and seventy-six one-hundredths ($89\frac{76}{100}$) for twenty-five hundred (2500) feet; a change to seventy-nine and two-tenths ($79\frac{2}{10}$) for nine hundred (900) feet, which embraces the whole three miles.

Q. 21. This carries you to mile-post two hundred and forty-three (243), does it?

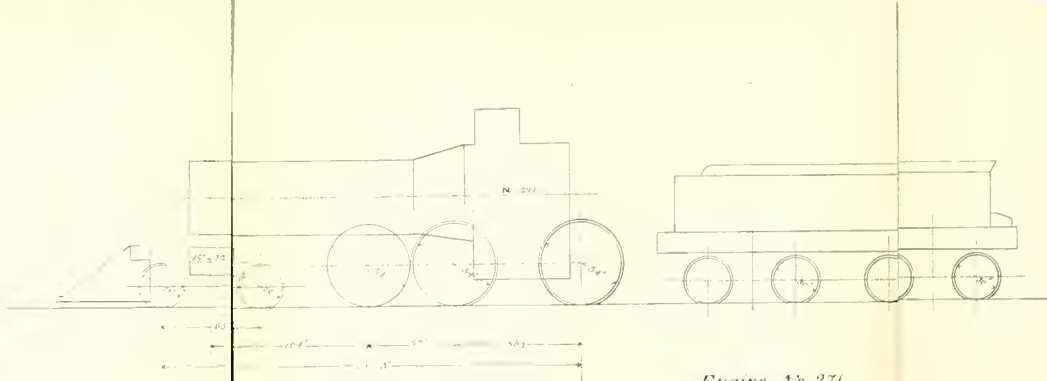
A. A little beyond, including the whole of the Horseshoe Curve.

(Tracing produced by witness, marked "Defendant's Exhibit, Altoona Grade, Robert N. Willson, Master.")

Q. 22. Have you any diagram or plan exhibiting the curvatures of the portion of the road of which you have just spoken?

A. Yes, sir.

Q. 22½. Please produce it?



Engine No 271.

Wt on Truck	22040 lbs.
" " Forward Drivers	10610 "
" " Middle "	17470 "
" " Back "	15390 "
Wt of Engine	72060 "
Wt of Tender	30550 "
Total Wt of Engine & Tender	102610 "

Defendant's Exhibit
Engine 271.

Robert H. Milson,
Master,

G. W. Swettenham

A. (Tracing produced, marked "Defendant's Exhibit, Horseshoe Curve, Altoona Grade, Robert N. Willson, Master.")

Q. 23. From the exhibit of the Horseshoe Curve can you tell what are the radii of the curves up to and including what is known as the Horseshoe Curve, that is to say, between the 240th and 243d mile-post?

A. Yes, sir.

Q. 24. Please give them, commencing at the 240th mile-post, and running the whole way.

A. The first curve west of mile-post 240 has a radius of twenty-two hundred and ninety-two (2292) feet; the next has a radius of nine hundred and fifty-three and thirty-seven one-hundredths ($953\frac{37}{100}$) feet; the next curve has a radius of nine hundred and fifty-three and thirty-seven one-hundredths ($953\frac{37}{100}$) feet; the next has a radius of eight hundred and nineteen and one one-hundredth ($819\frac{1}{100}$) feet; the next has a radius of twenty hundred and eighty-three and sixty-eight one-hundredth ($2083\frac{68}{100}$) feet; the next, which is the beginning of Horseshoe Curve, has a radius of six hundred and seventy-four and fifty-four one-hundredth ($674\frac{54}{100}$) feet. A little further on, the radius is six hundred and thirty-seven and twenty-seven one-hundredths ($637\frac{27}{100}$), and that is the last curve between those points.

Q. 25. How do these curves compare with curves on other parts of the road? Are they greater or less? Is the curvature more sharp on this part of the road than other parts, or not?

A. I do not know enough about the whole road to say where the least or the greatest curves are; but I know that the Horseshoe Curve is a longer curve than any one on the road, from having travelled it and seen it.

Q. 26. How do the grades on this part of the road compare with grades on the other parts of the road; are they steeper or less steep?

A. This is a fair representative three (3) miles of the grade on the east side of the mountain, which is the steepest grade on the road.

Q. 27. (Defendant's Exhibit "engine 271" shown witness.)

Are the weights contained on that exhibit accurate, so far as your knowledge goes?

A. Yes, sir; I weighed that engine myself, and those are the figures.

Q. 28. Did you get each result stated on that exhibit as a weight yourself?

A. Yes, sir.

Q. 29. (Defendant's Exhibit "engine 652" shown witness.) What do you know about the weights contained on that exhibit?

A. I was present when this engine was weighed, and those are the figures which were taken.

Q. 30. Are they correct?

A. Yes, sir.

Q. 31. (Defendant's Exhibit "engine No. 13" shown witness.) How as to the weights stated on that exhibit?

A. Those are the weights of the engine already stated as taken. I was present.

Q. 32. You saw it done?

A. I did.

Q. 33. And they are correct?

A. They are.

Q. 34. Did you witness any trials of engines made on the Altoona grade between the 240th and the 243d mile-posts, made recently with the dynamometer?

A. Yes, sir.

Q. 35. When were those trials made, about?

A. The last which I witnessed were made on the 14th of April; they were on that day.

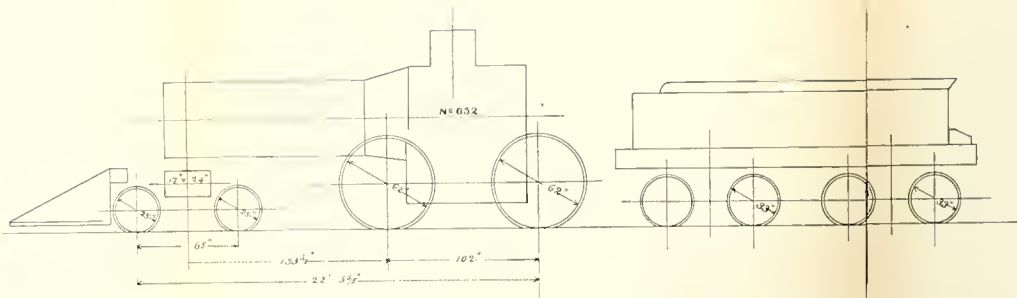
Q. 36. With what engines were those trials made?

A. They were made with Pennsylvania railroad engines, 271 and 652.

Q. 37. Was there any other engines there at that time, also, besides those two (2)?

A. No, sir.

Q. 38. How were those trials conducted? State fully what



Engine No 652.

W ^t on Truck	26000 lbs
" " Forward Drivers	23560 "
" " Back "	22200 "
Total W ^t of Engine	72060 "
W ^t of Tender	30550 "
Total W ^t of Engine & Tender	102610 "

G. W. Stratton

Defendant's Exhibit -
Engine 652

Robert N. Millson,
Master.

was done, giving, with the minutest details, all that was done for the purpose of making these trials?

A. Engine 271 had the main connecting rods taken down, and the swing truck which was under the engine was blocked so as to make it perfectly rigid and blocked in the centre of the truck. The engine was then placed in front of our dynamometer car, and engine 149 behind both to push. The dynamometer car is for the purpose of measuring and taking a continuous record of the force required to push a certain load or pull it.

Q. 38½. Just describe what a dynamometer is?

A. What is called the draw-spring of the car consists of five (5) concentric spiral springs. It is a sensitive spring and accurately tested. The spring, of course, is compressed in proportion to the load pulled or pushed. The motion which we get by the compression of the spring is the motion which gives us the results in the diagram; that is, this motion is multiplied by a system of levers, and works a pencil which is carried by a bar; and, of course, the more the spring compresses—that is, the greater the load pushed or pulled—the pencil will move from its normal point. At this normal point there is a pencil, which remains stationary; under those two pencil-points a paper is made to travel by machinery geared into the axle of the car, and consequently travels a definite distance for a definite distance travelled by the car. We thus get a straight line made by a stationary pencil, and another line, which I shall call the curve, made by the moving pencil. The area between those two lines represents the work done in pushing or pulling the load operated upon.

By THE MASTER:

Q. 39. Then you have some system by which you change that space into pounds, do you?

A. Yes, sir; a simple calculation.

Q. 40. In your trial of these engines, what did you do with it, after you fixed it in the way you have described?

A. We started from Altoona and pushed up the mountain to mile-post 243 from Philadelphia, and, during the trip, we took

a diagram of the force required to push engine 271 by means of the dynamometer car already explained.

Q. 41. Did you make more than one trial of engine 271 with a truck blocked or rigid?

A. Yes, sir; we went immediately back to Altoona, and repeated the experiment exactly.

Q. 42. And then did you repeat that experiment under the same conditions again, or under different conditions?

A. The third trip which we made was with the blocking removed from the swing truck, and the truck allowed to swing as it is intended to do.

Q. 43. Did you make any further trial with the swing truck free or swinging to the engine?

A. Yes, sir; and that experiment was repeated exactly, just as the former one was.

Q. 44. What results did you get, under trials one and two, with the truck rigid?

A. The average of experiments one and two figured, from the diagram taken, was twenty-seven hundred and forty-four pounds (2744).

Q. 45. And how many foot pounds?

A. It is equivalent to 14,488,320 foot pounds of work per mile.

Q. 46. Have you the diagram showing those trials, one, two, three, and four?

A. I have two of them, numbers one and three (diagram produced marked "Defendant's Exhibit, Diagram, Trial No. 1, Engine 271, Fixed Centre, Robert N. Willson, Master").

Q. 47. What results did you get with trials three and four, or with an engine having the truck free or swinging?

A. The average pull of experiments three and four was twenty-eight hundred and twenty-five (2825) pounds, which is equivalent to 14,916,000 foot pounds of work per mile.

Q. 48. What is the percentage of difference between those two sets of trials, and in favor of which truck, the rigid or the swinging?

A. The difference is 427,680 foot pounds of work per mile in

favor of the rigid truck, inasmuch as it takes less power. The per cent. is two and eighty-seven one-hundredths ($2\frac{87}{100}$) less power for the rigid truck than for the swing truck.

Q. 49. What was the average speed under which those four (4) trials were made?

A. I do not know.

Q. 50. What sort of an engine is 652?

A. 652 is a standard, class C, passenger engine.

Q. 51. And the other engine 271 was a freight engine?

A. Yes, sir.

Q. 52. Please state what trials were made with engine 652, which are numbered five, six, seven, and eight?

A. Four (4).

Q. 53. State what you did in making trial, called No. 5, with engine 652?

A. We pushed engine 652 over the same course, with the swing truck blocked, so as to be rigid in the centre of the truck.

Q. 54. Do you know at what rate?

A. No, sir.

Q. 55. And what did you do with trial No. 6, with the same engine?

A. We repeated No. 5, exactly.

Q. 56. And trial No. 7?

A. We pushed engine No. 652 with the swing centre truck free to swing, the blocking being knocked out; and trial No. 8 repeated No. 7 exactly.

Q. 57. What result did you get with trials 5 and 6, the truck being rigid?

A. The average push with trials Nos. 5 and 6 was twenty-eight hundred and fifty (2850) pounds, or 15,048,000 foot pounds per mile.

Q. 58. And what did you get as the result of trials 7 and 8?

A. The average of 7 and 8 was an average push of twenty-eight hundred and thirty (2830) pounds, or 14,942,400 foot pounds of work per mile.

Q. 59. What is the difference between those two (2) sets of trials, and in favor of which truck?

A. The absolute difference is 95,640 foot pounds of work per mile in favor of the swing truck; or, the swing truck required sixty-three one-hundredths ($\frac{63}{100}$) of one per cent. less power than the rigid truck.

Q. 60. What sort of drivers are on engine 652?

A. Flanged drivers.

Q. 61. Long or short base?

A. It has one hundred and two (102) inches base, which is longer than the average passenger engine.

Q. 62. That is, it is one hundred and two (102) inches from where and to where?

A. One hundred and two (102) between the driving-axles of engine 652, or what is generally called the wheel base. I mean from centre to centre of the driving-axles.

Q. 63. What is the entire wheel base of engine 652?

A. The entire wheel base of engine 652 is twenty-two (22) feet five and five-eighths ($5\frac{5}{8}$) inches, which is the distance between the points of contact of the front wheel of the engine and the rail and the point of contact of the back wheel of the engine and the rail.

Q. 64. How does the wheel base of the drivers, which is one hundred and two (102) inches, as you have already said, compare with the wheel base of ordinary passenger engines.

A. The majority of our passenger engines are the same, but, where there is a difference, it is a less distance than one hundred and two (102) inches.

Q. 65. Have you diagrams showing the result of trials 5, 6, 7, and 8, or any of them?

A. Yes, sir; I have of trials Nos. 6 and 7 (diagrams produced marked "Defendant's Exhibit, Diagram, Trial No. 6, Engine 652, Fixed Centre, Robert N. Willson, Master," and "Defendant's Exhibit, Diagram, Trial No. 7, Engine 652, Swing Centre, Robert N. Willson, Master").

Q. 66. (Defendant's Exhibit, Diagram, Trial No. 1, Engine 271, Fixed Centre, shown witness.) Is there any scale or other mode by which you can determine, approximately, the power expended in making that trial by the diagram shown you?

A. Here is a scale which is prepared from the data obtained by testing the spring (scale produced).

Q. 67. What data have you for testing that spring?

A. The dynamometer spring was tested and found to compress regularly seven sixty-fourths ($\frac{7}{64}$) of an inch for every five hundred (500) pounds added. The pencil on the movable bar was also found to move twenty-three sixty-fourths ($\frac{23}{64}$) of an inch, while the spring compressed seven sixty-fourths ($\frac{7}{64}$) of an inch. Therefore the twenty-three sixty-fourths ($\frac{23}{64}$) represents five hundred (500) pounds, and on that basis that scale was prepared.

(Scale marked "Defendant's Exhibit, Diagram Scale, Robert N. Willson, Master.")

Q. 68. This diagram scale refers to the eight (8) trials of which you have spoken?

A. Yes, sir.

Q. 69. Is there any other mode by which you can get at the exact result, as shown by the dynamometer?

A. No, sir; not the exact result.

Q. 70. How near?

A. The method which I have adopted in getting the area of these diagrams cannot be more than one-half of one per cent. out of the way. It should be very much nearer than that.

Q. 71. Will you explain that mode fully, and give the rule?

A. The method is known as Simpson's rule very generally, and the accuracy with which the result is obtained depends a good deal upon the time you have to devote to it. The whole figure is divided into smaller figures, by parallel lines perpendicular to the datum line. The lines, as shown on the diagram, are equidistant, and divide the whole diagram into a number of four-sided figures, one side being the curve of the diagram. By scaling the parallel lines and subdivisions to a point, which represents the average of the curve between any one line and its adjacent line, you can get the average push at that point. I have scaled all of these lines to the one-hundredth ($\frac{1}{100}$) of an inch, myself, and then applied Simpson's rule to calculate the area, which is simply to add together half the extreme ordi-

nates and all of the intermediate ordinates, and multiply that sum by the uniform distance the ordinates are apart.

Q. 72. Explain what an ordinate is?

A. I have called the perpendicular distance from the datum line to the curve at any one point the ordinate at that point.

Q. 73. (Defendant's Exhibit, Diagram Scale, shown witness.) How do you use that scale upon the several diagrams of the trials referred to by you?

A. You apply the zero line to the datum line of the diagram, and whatever division on the scale falls upon the curve of the diagram denotes the pull at that point.

Q. 74. How were the pencils caused to trace the diagram upon the diagram papers which have been produced by you?

A. The paper was drawn there underneath the pencil-point, between two (2) sets of two (2) rollers, which rollers were turned by a gearing into the axle of the car, and consequently the paper travelled proportionately to the speed of the car, and, from the gearings, the paper travelled very nearly seventeen (17) inches to every mile of road.

Q. 75. ("Defendant's Exhibit, engine No. 13," shown witness.) Was any trial made with engine No. 13, belonging to the Baltimore and Ohio Railroad Company, and if so, when and where?

A. Yes, sir; there was a trial made of this engine on the grade commencing at Piedmont, on the Baltimore and Ohio Railroad, on March 27th and March 30th.

Q. 76. Was there any trial made with engine No. 13 at Piedmont on the 27th of March, and if so, under what conditions was the trial made?

A. On the 27th of March engine 13 was hauled over the four-mile course, rigged as our standard engines; that is, with two pairs of flange drivers and a swing truck, the forward pair of drivers being plain—the engine has three pairs of driving-wheels.

Q. 77. What was the character of the three (3) pairs of drivers of engine 13, when you first took charge of her for your trial at Piedmont.

A. The engine had only the rear pair of drivers flanged, and had a rigid truck under it.

Q. 78. Then, as I understand your previous answer, you altered the middle pair of the drivers to flange wheels?

A. Yes, sir.

Q. 78. Before commencing your trial?

A. Yes, sir; the tires were taken off and flange tires put on.

Q. 79. Please go on, and state what you did?

A. We hauled engine No. 13 over the first four (4) miles west of Piedmont, with the swing truck, as I have stated, and from the last three (3) miles of that course I have figured that the average pull was twenty-five hundred and forty-two (2542) pounds.

Q. 80. Was that from the diagram?

A. Yes, sir; or 13,421,760 foot pounds of work per mile.

Q. 81. At what rate of speed did you make that trial?

A. The total time of that experiment was twenty (20) minutes and fifty (50) seconds for the four (4) miles.

Q. 82. That would be about twelve (12) miles an hour?

A. Yes, sir.

Q. 83. Did you repeat that trial?

A. Yes, sir; at a faster speed.

Q. 84. Give us that speed?

A. In the trial at a faster speed the average pull was twenty-six hundred and eleven (2611) pounds, or 13,786,080 foot pounds of work per mile.

Q. 85. What was the faster speed?

A. This time the speed was ten (10) minutes and seven (7) seconds for the four (4) miles.

Q. 86. Did you make a further trial, and if so, under what conditions?

A. On the 30th of March we experimented with the same engine, as we found the engine, when we went there, as the Baltimore and Ohio Railroad use it, with only the rear pair of drivers flanged, and with a rigid truck, as represented on Exhibit No. 13.

Q. 87. What was the result of that trial?

A. The first trial was an average pull of twenty-five hundred and forty-two (2542) pounds, which is equal to 13,421,760 foot pounds per mile. The time was nineteen (19) minutes and forty-one (41) seconds.

Q. 88. Did you repeat that trial?

A. Yes, sir; at a faster speed.

Q. 89. And in other respects under the same conditions?

A. In other respects exactly the same.

Q. 90. What was that faster speed?

A. The faster speed was ten (10) minutes and twenty-five (25) seconds for the four (4) miles.

Q. 91. What result did you get?

A. We got an average pull of twenty-five hundred and fourteen (2514) pounds, or 13,273,920 foot pounds of work per mile.

Q. 92. What was the average of the first trial on the 27th of March between the two (2) rates of speed and the average of the two (2) rates of speed on the 30th of March?

A. I have not made it up.

Q. 93. Can you give us the average between the slow rate with the fixed and the slow rate with the swing centre truck for those two trials?

A. The pull was the same at the slower rate of speed on the 30th and on the 27th of March.

Q. 94. Was there any difference between the fast rate of the 27th of March and the fast rate of the 30th of March, and if so, what was it?

A. At the fast speed, on the 27th and on the 30th of March, the pull required was greater on the 27th, or when the engine had the swinging truck.

Q. 95. How much per cent.?

A. Approximately four (4) per cent.

Q. 96. In favor of which truck?

A. The rigid truck.

Q. 97. Do any of the documents which you have made show that there is any difference in favor of the swinging or the fixed truck on straight roads?

A. Yes, sir.

Q. 98. In favor of which truck ?

A. The only documents which I have figured show a per cent. in favor of the rigid truck ; that is, it requires less on the straight track to push an engine with a rigid truck than with a swing truck.

Cross-examined.

By MR. HOLLINGSWORTH :

† Q. 99. What was the average push of your first experiment with engine 271 with the rigid truck ?

A. The average push of the experiment with engine 271 was twenty-seven hundred and three (2703) pounds.

† Q. 100. Now the second experiment with the same engine ?

A. The average of the second experiment was twenty-seven hundred and eighty-five (2785) pounds.

† Q. 101. Now give us the third and fourth experiments with swing trucks ?

A. Twenty-seven hundred and seventy-eight (2778) was the average on the third, and the average on the fourth was twenty-eight hundred and seventy-two (2872) pounds.

† Q. 102. You have already stated, in your examination in chief, what was the difference between the two (2) averages when you used the rigid truck and when you used the swing truck ?

A. Do you allude to any particular engine ?

† Q. 103. Yes, sir ; to this particular engine 271 ?

A. It is eighty-one (81) pounds.

† Q. 104. Then the average difference between the two experiments, the one with the rigid truck and the one with the swing truck, was not as great as the average difference between the two experiments where you used the same kind of a truck ?

A. There were two (2) sets of two (2) experiments each.

† Q. 105. I am speaking of engine 271 ?

A. So am I.

† Q. 106. The average push of the first experiment with engine 271 was twenty-seven hundred and three (2703), and of the second experiment, twenty-seven hundred and eighty-five (2785),

and the difference between those two would be eighty-two (82), would it not?

A. Yes, sir.

† Q. 107. The average push of the third experiment was twenty-seven hundred and seventy-eight (2778) pounds, and in the fourth experiment, twenty-eight hundred and seventy-two (2872), and the difference is ninety-four (94), is it not?

A. It is.

† Q. 108. The first and second experiments were made with a fixed truck?

A. Yes, sir.

† Q. 109. The third and fourth were made with a swing truck?

A. Yes, sir.

† Q. 110. What is the average push of the first and second experiments together, both made with the fixed truck?

A. Twenty-seven hundred and forty-four (2744) pounds.

† Q. 111. What is the average of the third and fourth experiments, both with the swing truck?

A. Twenty-eight hundred and twenty-five (2825) pounds.

† Q. 112. What is the difference between those two last averages?

A. Twenty-seven hundred and forty-four (2744) subtracted from twenty-eight hundred and twenty-five (2825), leaves eighty-one (81) pounds, as I subtract.

† Q. 113. Therefore, the difference between the average on the four (4) experiments, in two (2) of which you used the fixed truck, and in two (2) of which you used the swing truck, is less than the average of the two (2) experiments in which you used the fixed truck alone, or the two (2) of which you used the swing truck alone?

A. Yes, sir; it is less.

† Q. 114. Then, if you compare the average push of the first experiment with the fixed truck with the average push in the second experiment with the fixed truck, you find that the difference is greater than the difference between the two (2) sets of

experiments in which you used the fixed truck and the swing truck?

A. It is so, certainly.

† Q. 115. How was the engine No. 13 on the Baltimore and Ohio Railroad connected with the car on which the dynamometer was?

A. The engine was hooked behind the car.

† Q. 116. How?

A. It was coupled up with an ordinary coupling-pin and a drawbar from the engine, if I recollect rightly. There was also, to prevent any breaking from the engine getting away, a chain fastened between them so that if the bar or pin broke the chain would hold. The pull did not come on the chain, though.

† Q. 117. To what part of the engine which was pulled was the drawbar attached?

A. It was attached to the front part to a piece of the upper part of the pilot, if I remember correctly—I did not take particular notice of that—the same as ordinary engines.

† Q. 118. It was attached to the extreme forward end of the engine, was it not?

A. It is not the extreme forward point of the engine, because the extreme forward point of the engine is the end of the pilot.

† Q. 119. Will you tell me why you took the flanges off that engine when you tried it with a fixed truck, instead of leaving the engine in other respects in the same condition as it was when you tried it with a swing truck.

A. Because we wanted to try it as the Baltimore and Ohio Railroad people run the engine.

† Q. 120. Would it go around the curves easier with the flanges on or off?

A. As an average of the whole experiment that I saw there, it goes around the curves easier without the flanges forward, and with the rigid truck, than it does with the flanges on and with a swing truck.

† Q. 121. That is not the question which I asked you.

A. That is what I understood you.

† Q. 122. I will repeat it; taking an engine with a rigid truck,

would that engine go around a curve easier with the flange off, or with the flange on the forward drivers?

A. I give it up.

† Q. 123. You do not know?

A. No, sir.

† Q. 124. Which would go around the curve easier—a swing truck with the flanges off or on?

A. Well, I do not know that, for I never tried one with the flanges off and a swing truck.

† Q. 125. Do you know what it costs to alter a swing truck into a rigid truck?

A. No, sir.

† Q. 126. In those experiments, did you push the tender as well as the locomotive?

A. Yes, sir; we did the same as is shown in those tracings with weights, as given in Defendant's Exhibits, engine No. 13, engine 652, and engine 271.

† Q. 127. What was the object of pushing the tender when you wanted to get the resistance of the engine?

A. The reason, I take it, was that the engine and tender belong together and go together, and the diagram which we get was more satisfactory to figure from with a heavier load, simply because you have a larger area. I would say, however, that the difference between the rigid and the swinging truck would be a larger per cent. of the difference with the engine alone than it would be with the engine and tender.

† Q. 128. Just look at "Defendant's Exhibit, Trial No. 6, Engine 652," and tell me what was the greatest variation in pounds of the dynamometer between the highest and lowest pressure shown?

A. I cannot give this accurately in so little time, but I see that at one point near the beginning of this course it reaches as low as fifteen hundred (1500) pounds, and for a point on the curve it reaches as high as thirty-seven hundred (3700) pounds, where there is a difference in curvature and a difference in elevation.

† Q. 129. I call your attention to the same exhibit, near where

the figures "112" are marked on it; tell us what the variation is in that section alone?

A. Sixteen hundred (1600) four thousand (4000)—twenty-four hundred (2400) pounds. I can explain that if you wish.

By THE MASTER:

† Q. 130. You say you can explain that difference?

A. Certainly.

† Q. 131. What is the cause of that difference?

A. It is simply because the engineer shut down his steam at the point when it is low, and opened it out at the point where it went up.

† Q. 132. Did that occur every time where these changes occur on the diagram?

A. No, sir; but I have noticed that where any such decisive change as that occurs, it is caused by that very thing. The momentum of the train comes in, of course, when he shuts off, and changes the ordinate.

By MR. HOLLINGSWORTH:

† Q. 133. (The witness's attention is called to "Defendant's Exhibit, Diagram No 1, Engine 271.") What is the variation in the section marked "A"?

A. Twenty-four hundred (2400) pounds.

† Q. 134. What is it in the section marked "B"?

A. Eighteen hundred (1800) pounds.

† Q. 135. What is it in the section marked "C"?

A. Twenty-five hundred (2500).

† Q. 136. What is it in the section marked "D"?

A. Twenty-five hundred (2500).

† Q. 137. These distances, in your opinion, are all caused by letting on or shutting off steam in the locomotive?

A. They are caused by variations of speed alone.

† Q. 138. But are those differences, in your opinion, caused by shutting off or letting on steam in the locomotive?

A. What do you mean by letting on and shutting off steam?

† Q. 139. Precisely what you mean in the words used by your-

self; are those changes, in your opinion, caused by shutting off or letting on steam in the locomotive?

A. Where there is a great difference, I think it is. Where it is small, I account for it by the taking of steam on one side of the engine and the other, alternately. When the engine takes steam on either side or when she strikes a rail-joint, or, in fact, when any such cause occurs, it would produce these irregularities.

† Q. 140. Where are the other diagrams used in these experiments?

A. The other diagrams taken are at Altoona.

MR. HOLLINGSWORTH: I call upon the gentlemen upon the other side to produce them.

By MR. HOLLINGSWORTH:

† Q. 141. Before these experiments on the 14th of April, did you make any other experiments with swing and fixed trucks?

A. Yes, sir.

† Q. 142. Where are the results of those experiments?

A. Well, there is a record of them at Altoona.

Signature of deponent waived by consent of counsel.

ISAAC DRIPPS, a witness produced on behalf of the defendant, is sworn, examined, and says:

By MR. BIDDLE:

Question 1. Where do you reside?

Answer. Philadelphia.

Q. 2. Are you in any business now?

A. Not in any business at present.

Q. 3. How long have you been out of business?

A. About a couple of years.

Q. 4. How old are you?

A. Sixty-six (66).

Q. 5. What was your business before you gave it up?

A. I was Superintendent of Motive Power on the Pennsylvania Railroad, at Altoona.

Q. 6. And how long had you been Superintendent of Motive Power at Altoona?

A. Two (2) years.

Q. 7. What had you been before that?

A. The year before I was Inspector, appointed by Mr. Thomson, of shops, tools, and machinery for the road. That was only for one year. Before that I was Master Mechanic of the western division of the Pittsburgh, Fort Wayne, and Chicago Railway.

Q. 8. How long a time were you Master Mechanic of the Pittsburgh, Fort Wayne, and Chicago Railway?

A. Ten (10) years.

Q. 9. And what was your business prior to that?

A. I was for a few years in business at Trenton, manufacturing locomotives and cars. Before that I was the Superintendent of Machinery, it was termed, on the Camden and Amboy Railroad.

Q. 10. For how long?

A. I was there twenty-two years, I think. I commenced there in 1831.

Q. 11. Then you are one of the oldest Master Mechanics in the country?

A. I believe I am at the present time, the oldest so far as I know.

Q. 12. As a matter of course, from what you have said in respect to your business you are familiar with both the swinging trucks and fixed trucks on locomotive engines, are you not?

A. Not particularly with the swing truck. With the rigid truck, I am. I always used that until I came on the Pennsylvania Railroad, which was the first I had anything to do with the swing centre truck; and then my business as Superintendent of Motive Power was so that I could pay but very little attention to the working of those trucks on the road.

Q. 13. Do you know anything about the dynamometer which Mr. Cloud, the previous witness, has spoken of?

A. I do.

Q. 14. What do you know about it?

A. I know all about it. I designed it myself, and had it built for the express purpose of testing such things as locomotives, or anything else, to see the power required to pull things on a railroad.

Q. 15. How came you to make that dynamometer; what led you to invent or construct it?

A. What brought that about was this: Before the death of Mr. Thomson, the President of the Pennsylvania Railroad Company, several of the Superintendents of the different divisions, asked for those large consolidated engines, weighing very heavy, one weighing nearly ninety thousand (90,000) pounds. Mr. Thomson objected to allowing such heavy engines to go on the road; but one of the Vice-Presidents insisted upon it, and Mr. Thomson delegated me to examine into the matter, and report about those engines. I did not want to go and look at the engines, and give a verbal report, and I proposed to make a dynamometer, so that we could get figures for it, and find out the number of pounds it would require for the different classes of engines. He agreed to it, and I had the dynamometer built from drawings I made myself.

Q. 16. Have you those drawings with you?

A. I have drawings, but they are rather imperfect. Still they will show the machine, so that it could be understood.

Q. 17. After you made this dynamometer, did you use it for Mr. Thomson, and, if so, what were the general results of its use?

A. We did. Those large engines that are termed the consolidated class of engines, on the Philadelphia and Erie road. I went up to Renova, where the shops are, and there we tried the experiments on the three different classes of engines, the passenger four-wheel connected engines, the six-wheel connected freight engine which are generally termed ten-wheel engines, and the large consolidated freight engines, with eight wheels connected. We tried them around a heavy curve, near Renova, and we drew those different class of engines around the curve and the result was—I cannot give the exact figures, but I can

give round numbers near enough—the passenger four-wheel connected engine required twenty-four hundred (2400) pounds to pull it around the curve, the six-wheel connected engine required eighteen hundred (1800) pounds, and the large consolidated engine or eight wheels connected came in between the two and required nineteen hundred (1900) pounds. That was the result of the trial with the three different classes of engines.

Q. 18. The result of all that was that the larger the engine the less power required to move it?

A. Well, according to the construction of the three (3) different classes it did; but they were differently arranged. I would also state, that the result of those experiments was, that the Pennsylvania Railroad Company adopted this large consolidated class of engines as one of the standard freight engines for the road.

By THE MASTER:

Q. 19. What do you mean when you speak of eighteen hundred (1800) and nineteen hundred (1900) and two thousand (2000) pounds power required to pull an engine around a curve; did you attach one engine to another?

A. Yes, sir; we pulled the engine we experimented with by the dynamometer car, and the dynamometer indicated the number of pounds to pull the engine around the curve. We pulled those engines separately.

By MR. BIDDLE:

Q. 20. Do you know of any other experiments having recently been made at Altoona, by means of the dynamometer, with the swing truck and the fixed truck?

A. I do; I witnessed those experiments myself.

Q. 21. You witnessed those which Mr. Cloud spoke of?

A. Yes, sir.

Q. 22. Before those trials were made, did any one test the spring of the dynamometer?

A. Yes, sir; I tested it myself, personally, or, rather, the correct answer would be, that I stood by and inspected while it was

tested, and took the numbers as they were given, so that I know they are correct.

Q. 23. Were you on the engine during the several trials, which have been numbered from one to eight?

A. I was in the dynamometer car, of course, observing the operation of the machine in all these experiments.

Q. 24. ("Defendants' Exhibit, Diagram Trial No. 1," and "No. 3," "with Engine 271;" and "Diagram Trial No. 6" and "No. 7," "with Engine 652," shown witness.) Did you see those diagrams made in the manner described by Mr. Cloud?

A. I did. I was present during the whole of those trials.

Q. 25. When the trial No. 1 was made, was the truck blocked or made rigid?

A. The truck was blocked.

Q. 26. And trial No. 2 was a repetition of trial No. 1, was it not?

A. Trial No. 2 was a repetition of the same engine in the same condition.

Q. 27. Trial No. 3 was with what?

A. Trial No. 3 was with a swing truck, the block being taken out; and trial No. 4 was the same repeated.

Q. 28. Now tell us what trial No. 5, with engine 652, was?

A. That was a passenger engine. The central portion of the truck was blocked, making it a rigid truck; and the 6th was the same repeated.

Q. 29. How was No. 7?

A. No. 7 was with the block removed, making the truck swing; and 8 was a repetition of 7.

Q. 30. Were you present, on the 27th of March last, at Piedmont, and also on the 30th of March, when the trials were made with engine No. 13 of the Baltimore and Ohio Railroad Company?

A. I was.

Q. 31. There were two (2) experiments made with a fixed centre truck or rigid truck, and two (2) with the swing truck, were there not?

A. Yes, sir.

Q. 32. Have you heard Mr. Cloud's testimony on that subject?

A. I was present here ; yes, sir.

Q. 33. Did you hear it?

A. Yes, sir.

Q. 34. Do you agree with him, or not, in his statement of facts in regard to the value of the swinging truck, as compared with the fixed truck?

(Objected to. Objection sustained.)

Q. 35. Do you know what the grades on the Pennsylvania Railroad are between mile-posts 240 and 243?

A. No, sir ; I do not, any more than what I see on the papers here.

Q. 36. Do you know where what is called the Horseshoe Curve is?

A. I do, very well.

Q. 37. Please state where it is?

A. It is between the fifth and sixth mile-posts, west from Altoona. I think it comes in between these two (2) miles. I cannot give you the exact number on the posts from Philadelphia, but I think it is between five (5) and six (6) miles from Altoona, west.

Q. 38. And about what length or distance does that Horseshoe Curve embrace?

A. I think it occupies, going west, somewhere about half a mile ; I should judge about that.

Q. 39. Do you know what the curvature of the road is which includes the Horseshoe Curve, and two miles east and one mile west of it?

A. No, sir ; I do not. I know there is a series of curves there ; but what the curvature is I do not know.

Q. 40. Do you know how those curves compare with the curves on the rest of the line between Philadelphia and Pittsburgh?

A. I think the heaviest curves on the road are there, and I think the Horseshoe Curve is the heaviest curve on the road. At least I only know it in this way, when I was on the Fort Wayne road I had occasion to make inquiry of the heaviest curves on

the Pennsylvania road, on account of ears which we were building which were to run over the Pennsylvania road, and the answer that was sent back to me was that this Horseshoe Curve was the shortest curve on the road, and that it was six hundred (600) feet radius. That is the way I know.

Q. 41. Did you take the result of trial No. 1, referred to by Mr. Cloud?

A. No, sir; I had nothing to do with the figuring whatever. I only witnessed the experiments, and know they were correct. The figuring Mr. Cloud has done altogether.

Q. 42. ("Defendants' Exhibit, Diagram Scale," shown witness.) Have you used that scale for the purpose of testing the power expended in driving the engine in any of these trials?

A. This scale is made for the express purpose of measuring the number of pounds that the dynamometer indicates on these diagrams. That is a scale made for that purpose.

Q. 43. Who made that scale?

A. I made it myself.

Q. 44. Have you used that scale for the purpose of ascertaining the power expended in any of these trials, Nos. 1 to 8?

A. No, sir; I have not.

Q. 45. Can you do it, so as to give the result at once?

A. I can by laying this rule on the diagram and taking the average of the vibrations of the peneil, and judge from that.

Q. 46. And the result would be the number of pounds, according to the measurement on the scale?

A. Yes, sir.

Q. 47. Will you take one of those diagrams and apply that scale and give us the number; give us, for instance, the number of pounds as indicated by the dynamometer on trial number one, with engine 271, where the diagram is marked with the figures 111?

A. I would say that the average would be twenty-seven hundred (2700) pounds at that point.

Q. 48. Now give us the number of pounds, where the diagram is marked "112?"

A. At the 112th mile-post, it would be twenty-nine hundred (2900) pounds.

Q. 49. What would it be at the 113th mile-post, or near that?

A. That would be twenty-four hundred and fifty (2450) pounds.

Q. 50. And at the 114th mile-post.

A. That would be twenty-eight hundred (2800) pounds.

Q. 51. With what kind of a truck were all those experiments made? ("Defendants' Exhibit, Trial No. 1," shown witness.)

A. It is marked "fixed truck."

Q. 52. ("Defendants' Exhibit, Trial No. 3, with Engine 271, with a Swinging Truck" shown witness.) Give the measurement at the 111th mile-post?

A. Twenty-seven hundred (2700) pounds.

Q. 53. Now at the 112th mile-post?

A. Twenty-eight hundred (2800) pounds.

Q. 54. Now at the 113th mile-post?

A. That would be three thousand (3000) pounds.

Q. 55. Now at the 114th mile-post?

A. That would be twenty-eight hundred (2800) pounds.

Q. 56. ("Defendants' Exhibit, Trial No. 6, with Engine 652" shown witness.) Give the number of pounds at the 111th mile-post?

A. Twenty-six hundred (2600) pounds.

Q. 57. Give the number of pounds at the 112th mile-post?

A. Twenty-eight hundred (2800) pounds.

Q. 58. Give the number of pounds at the 113th mile-post?

A. Twenty-eight hundred (2800) pounds.

Q. 59. Give the number of pounds at the 114th mile-post?

A. Three thousand (3000) pounds.

Q. 60. ("Defendants' Exhibit, Trial No. 7, with Engine 652, with the Swinging Centre Truck," shown witness.) Give the number of pounds at mile-post 111?

A. Twenty-six hundred (2600) pounds.

Q. 61. Give the number of pounds at mile-post 112?

A. Twenty-seven hundred (2700) pounds.

Q. 62. Give the number of pounds at mile-post 113?

A. Thirty-one hundred (3100) pounds.

Q. 63. Give the number of pounds at mile-post 114?

A. Three thousand (3000) pounds.

Q. 64. What results did you get with trials No. 1 and 2, or with the truck rigid?

(Objected to.)

THE MASTER: The witness can answer the question, as far as any result which he may have personally observed is concerned.

THE WITNESS: As I said before, I have not examined anything on these diagrams, any further than what I have just now measured by the rule, and I do not know anything about the calculation by Mr. Cloud. Therefore I am unable to answer that in any other way.

By MR. BIDDLE:

Q. 65. Did you observe the indicator or dial, that is connected with the dynamometer?

A. I did.

Q. 66. Describe the indicator or dial attached to the dynamometer?

A. There is an indicator that is intended for observation. On this dial plate, there are a number of pounds marked, and the indicator, as the car moves, moves around back and forth, and you can tell by observation the number of pounds you are pushing; but the vibrations are so great that you cannot get it accurately.

Q. 67. Did your observation of the indicator correspond with the results which Mr. Cloud reached?

(Objected to. Objection sustained.)

Q. 68. What was the result of your observations of the indicator?

A. Any observation that I made during the experiments was only for a short time, as my attention was called to other parts of the experiments; but, so far as the indications of the pointer are concerned, they must tally with the diagram shown here, because they work precisely alike, and the indications of the one

must be the same as the other. Any observations made on the indicator during our experiment were but a short time, because I was looking out examining the mile-posts, and the condition of the engine when we were trying those experiments; but the result of the pointer, and the diagram made must agree, for they work exactly the same.

Q. 69. Do you know the percentage of difference between the two (2) sets of trials, No. 1 and 2 in one set, and No. 3 and 4 in the other set, and, if so, state it?

A. I only know from being informed by Mr. Cloud what the result was.

Q. 70. At what rate of speed was trial No. 1 made?

A. I do not know what the rate of speed was, but this I do know, that the return made here by Mr. Strattan is correct. I know that the return made by Mr. Strattan here is correct, because I kept the time at the same time with him, and we compared at the end of each experiment. I made a rough note of it, and have not written it out since; but I can say positively, that the paper he returned is correct, because I kept it myself.

Q. 71. As to the rate of speed of trial No. 2, do you make the same answer?

A. I make the same answer.

Q. 72. And do you make the same answer as to trial No. 3?

A. The same answer.

Q. 73. And do you make the same answer to trial No. 4?

A. The same answer.

Q. 74. Do you make the same answer as to the rate of speed of the trials numbered 5, 6, 7, and 8?

A. I can only return the same answer.

Q. 75. And your answer is that what Mr. Stratton returned is correct?

A. That I know because I examined it afterward and compared it. I made a rough note of it at the time it was made; but I have not copied it since.

Q. 76. What was the condition of engine No. 652 on this first trial, or trial No. 5?

A. The swing truck was blocked to make a rigid truck.

Q. 77. And No. 6; was that also the same?

A. No. 6 was the same; the experiment was repeated under the same circumstances.

Q. 78. Did you examine those blockings?

A. I did; I examined the blockings when the block was first put in, when it was first blocked. I examined it to see that it was correctly done, and whether it was kept in the centre and the blocking was screwed tight—which it was. Then, at the end of the experiment, I examined it to see if the blocking was screwed tight still, which it was, and perfectly solid, so that the operation of the truck during the experiment was the same as a rigid frame truck.

Q. 79. In trial No. 7, how was the truck?

A. The blocks in the truck were removed, making a swing centre truck.

Q. 80. And in No. 8?

A. And No. 8 was the same experiment repeated.

Q. 81. Do you know what the wheel base of engine 652 is?

A. I do not; I did not measure it.

Q. 82. Did you know how the base of that engine compares with the defendants' other exhibits?

(Objected to. Objection overruled.)

A. They have other engines with a shorter distance between centre and centre of the driving wheels, but how much I cannot say; and I would further add that I know the tracings on "Defendants' Exhibit, Engine 652," must be correct, and that the tracings on "Defendants' Exhibit, Engine 271," must be correct, because they are taken from the records.

Q. 83. Do you know of any engine owned or operated by the defendants, having a greater wheel base of drivers than engine 652?

A. No, sir; not between the two driving wheels. They have no engine with any greater distance than that which is given there as one hundred and two (102) inches between the centres of the driving axles.

Q. 84. Were you present at the experiments at Piedmont referred to by Mr. Cloud?

A. I was.

Q. 85. On both occasions?

A. On both occasions.

Q. 86. How was the first trial at Piedmont conducted, with a fixed or swinging centre truck—that is, the one on the 27th of March?

A. It was a solid truck frame, a rigid truck frame, with four blind tires, or, in other words, there were only flanges on the hind drivers with six (6) driving wheels.

Q. 87. Like “Defendants’ Exhibit, Engine No. 13?”

A. Yes, sir; that is it.

Q. 88. How many trials were made with a fixed truck on that occasion?

A. Two (2) trials.

Q. 89. At what rate of speed was the first trial made?

A. The time I cannot give correctly, for my attention was called to other things, so that I did not get the correct time of those two experiments. The time was taken by other parties. Mr. Harrison took it, and from the fact that I knew that Mr. Harrison was taking it, I neglected it at the time.

Q. 90. As to the second trial on that day, what was the rate of speed?

A. The rate of speed I could not say was correct. I have it here (referring to memorandum), but I cannot say it is correct.

Q. 91. Under what conditions was the first trial made on the 30th of March?

A. I have not noted how the truck was, but my recollection is that the trial was made with a solid frame truck. I see I have not noted it on the experiment, but that is my recollection of it.

Q. 92. Do you know with what rate of speed that first trial on the 30th of March was made?

A. No, sir; I have the time here on my memorandum, but I would not like to give it as correct.

Q. 93. Was there any other trial on that day, the 30th of March?

A. Yes, sir; there were two (2) trials with the same engine.

Q. 94. Was the second trial made under the same or different conditions, on that day?

A. I think they were under the same conditions.

Q. 95. Do you mean to say that both the experiments that were made, on the 27th of March and on the 30th of March, were made with fixed trucks?

A. The trial on the 27th of March was made with a fixed truck. On the 30th of March, I see I have not marked it down, and I cannot recollect it, but my impression is that it was a fixed truck; my recollection is that it was a fixed truck.

Q. 96. But, of the trial on the 27th, you speak from a note made at the time in regard to the condition of the truck?

A. Yes, sir; the reason why I think so is, that the first trial was made on the 27th, and we did not suppose it was a perfect trial. The condition of the rail was not as good as we supposed it ought to be to give it a fair trial, and we insisted upon trying it over again, and went up on the 30th for the purpose of trying that experiment over again. So that my recollection of it is that it was a fixed truck under the engine on the first trial.

Q. 97. Do you know what the grade on the Baltimore and Ohio Railroad is, at Piedmont, where these trials were made?

A. I do not of my own personal knowledge.

Q. 98. Are those grades light or heavy?

A. They are heavy grades—the commencement of the ascent of the mountain. The mountain grades commence at Piedmont, going west, and are heavy grades.

Q. 99. Do you know what the curve of the road is, at Piedmont, where the experiments were made?

A. No, sir; I do not, any more than I can judge by observation. The curves were pretty heavy, but what their curvature was I do not know—I mean sharp curves.

Q. 100. Were the grades at Piedmont, where these experiments were made, heavier than the grades at Altoona, where the other trials were made?

A. I could not say; I do not know.

Adjourned until Friday, May 5th, 1876, at 10 o'clock A.M.

PHILADELPHIA, Friday, May 5th, 1876.

Parties met, pursuant to adjournment, at the office of the Master, Robert N. Willson, Esq., No. 216 South Fourth street, at 11 A.M.

Present: S. S. Hollingsworth, Esq., H. B. Renwick, Esq., for complainants; Chapman Biddle, Esq., and S. M. Whipple, Esq., for defendants.

The counsel for the defendants invited the counsel for the complainants, and Messrs. Renwick & Moore, and the Master to be present at Altoona, on the 19th of May, to witness certain trials with locomotive engines with the swing and fixed trucks attached to, a dynamometer car, up the grade from Altoona to the end of the Horseshoe Curve, near the 111th mile-post, east from Pittsburg.

Adjourned to meet at the call of the Master.

PHILADELPHIA, Tuesday, June 6th, 1876.

Parties met at the call of the Master, at his office, No. 216 South Fourth street, at 3.30 P.M.

Present: S. S. Hollingsworth, Esq., H. B. Renwick, Esq., for complainants; Chapman Biddle, Esq., and S. M. Whipple, Esq., for defendants.

EXAMINATION OF ISAAC DRIPPS, RESUMED.

THE WITNESS: Before the examination commences this afternoon, I would like to correct some of my answers made at the

previous examination. In answer to Question 86, which was: "How was the first trial at Piedmont conducted, with a fixed or a swing centre truck, on the 27th of March?" I answered incorrectly. I will say that on the 27th of March we tried experiments with both the rigid and swing centre trucks on engine No. 13 of the Baltimore and Ohio Railroad, the same engine that is named in the defendants' exhibit. The first trials were with a rigid truck, but we did not take account of them, as we considered them defective. The only trial that was taken account of was the last trial with a swing truck. We concluded the trial on the 27th. On the 30th we went to Piedmont, and made another trial with the same engine with a rigid truck.

I would also state, that in the trial on the 30th of March, with a rigid truck, there were no flanges on the four front driving-wheels. There was only a flange on the tire of the back driving-wheels.

I believe that is all I have to say about that.

By MR. BIDDLE:

Question 101. Was there a diagram taken on the first and second trials of engine No. 13 of the Baltimore and Ohio Railroad Company, on the 27th of March last, with a swing centre truck.

Answer. There was.

Q. 102. What was the average push in each case as shown by diagram marked: "Experiment No. 5, Engine No. 13, B. & O. R. R., Swing Truck Piedmont, 3-27-76, slow speed." Have you worked this out?

A. I have worked two of them that I know to be correct. The other two were so imperfect that I did not work them out. I think that is one that I could not decipher.

Q. 103. Did you work out Experiment No. 6, also on the 27th of March?

A. Yes, sir; I think I did.

Q. 104. Be kind enough to answer the question as to No. 6?

A. As to No. 6, I examined the diagram and found that the average pull there amounted to twenty-six hundred and thirty-four (2634) pounds.

Q. 105. Was there not another diagram that you examined?

A. There was.

Q. 106. What was that other diagram that you examined?

A. It must have been one on the 30th, either No. 1 or No. 2,—I was mistaken about that. I say now that I examined both Experiments Nos. 1 and 2, made on the 30th of March, 1876.

MR. BIDDLE: We offer in evidence these diagrams which the witness says he has examined.

THE WITNESS: I wish to correct my answers. I find there have been two which I examined, namely, Nos. 1 and 2, on the 30th of March. I have not examined 5 and 6. The reason why I know that I have examined Nos. 1 and 2 is because I find the division marks which I made, on the diagrams of Nos. 1 and 2. I am certain that those are the two.

(The diagrams offered in evidence by Mr. Biddle, marked: "Defendants' Exhibit, Experiment No. 1, Engine No. 13, B. & O. R. R., Rigid Truck Piedmont, 3-30-76, slow speed. Robert N. Willson, Master.

"Defendants' Exhibit, Experiment No. 2, Engine No. 13, B. & O. R. R., Rigid Truck Piedmont, 3-30-76, fast speed. Robert N. Willson, Master.")

By MR. BIDDLE:

Q. 107. What was the average pull in each case as shown by Diagrams Nos. 1 and 2?

A. No. 1 was twenty-five hundred (2500) pounds, and No. 2 was twenty-four hundred and eighty-six (2486) pounds. They were both with a rigid truck. I wish to withdraw my answer relative to Experiment No. 6. The pounds given are correct, as stated by the diagram, but I did not examine Diagram No. 6.

By THE MASTER:

Q. 108. What do you mean by that? You say that the pounds given are correct, but that you did not examine the diagram?

A. Well, that comes in this way: I was under the impression that I had examined Diagram No. 6, as I so stated. I was

asked what power Diagram No. 6 had, and I gave it, but I did not examine No. 6.

Q. 109. Do you mean that you gave it from a calculation made by somebody else and reported to you, or how do you mean that you got at it?

A. It was a calculation made by Mr. Cloud.

Q. 110. Then you speak of it as correct because you have confidence in Mr. Cloud's calculation?

A. Yes, sir; I believed it to be correct.

By MR. BIDDLE:

Q. 111. Have you, since you were here before, examined the diagram: "Defendants' Exhibit, Diagram Trial No. 1, Engine 271, Fixed Centre; Diagram Trial No. 3, Engine No. 271, Swing Centre; Diagram Trial No. 6, Engine 652, Fixed Centre; Diagram Trial No. 7, Engine 652, Swing Centre?"

A. I have examined the whole of them, the whole eight.

Q. 112. Did you examine also four other diagrams: "Experiment No. 2, with Engine 271, with Rigid Truck, April 14th, 1876, fast speed," and "Experiment No. 4, with the same engine, Swing Truck, same time, fast speed." Also, "Experiment No. 5, with Engine No. 652, Rigid Truck, Altoona, 14th of April, 1876," and "Experiment No. 8, with Engine 652, Swing Truck, Altoona, 14th of April, 1876, fast speed?"

A. I did.

MR. BIDDLE: I offer in evidence:

"Defendants' Exhibit, Diagram Trial No. 5, Engine 652, Fixed Centre Truck. Robert N. Willson, Master."

"Defendants' Exhibit, Diagram Trial No. 8, Engine 652, Swing Centre Truck. Robert N. Willson, Master."

By MR. BIDDLE:

Q. 113. What was the average push of engine 271 on the first trial and on the second?

A. The average for trial No. 1 was twenty-seven hundred and thirteen (2713) pounds; for trial No. 2 it was twenty-eight hundred and twenty-seven (2827) pounds.

Q. 114. What was the average of those two trials with the rigid truck ?

A. It was twenty-seven hundred and seventy (2770) pounds.

Q. 115. What was the average push of the same engine on the first and second trials with the swing truck ?

A. It was twenty-seven hundred and ninety-eight (2798) pounds, with trial No. 5, or the first trial with the swing truck.

Q. 116. What was the other trial ?

A. Trial No. 6, or the second trial with the swing truck, was twenty-eight hundred and forty-two (2842) pounds.

Q. 117. What was the average of those two trials ?

A. Twenty-eight hundred and twenty (2820) pounds.

Q. 118. What was the average push on engine 652 on its first trial, and what was its average push on this second trial, both being with a rigid truck ?

A. The first trial was twenty-nine hundred and eighteen (2918) pounds ; the second trial was twenty-eight hundred (2800) pounds.

Q. 119. What was the average then of those two trials ?

A. The average was twenty-eight hundred and fifty-nine (2859) pounds.

Q. 120. What was the average push of engine 652 on the first trial with the swing truck or trial No. 7, and the second trial or trial No. 8 ?

A. The first trial No. 7 with the swing truck was twenty-eight hundred and twenty (2820) pounds ; the second trial No. 8 with the swing truck was twenty-eight hundred and fifty (2850) pounds.

Q. 121. What was the average of those two trials ?

A. Twenty-eight hundred and thirty-five (2835) pounds.

Q. 122. Since the adjournment, on the 5th of May last, have you witnessed any further experiments with engines 271 and 652 at Altoona on the 19th and 20th days of May ?

A. I have.

Q. 123. Will you please describe these experiments, giving their order and the conditions under which they were made ?

A. We commenced the experiments with engine 271, having

the main connecting rods taken off, and being pushed ahead of the dynamometer car. The first trial was made with a swing truck with tender attached. We ran the usual course from mile-post 240 to mile-post 243 from Philadelphia.

Q. 124. Does that include the Horseshoe Curve?

A. It includes the Horseshoe Curve. The second trial was made with the same engine with a swing truck without tender, and we ran over the same course. The third trial was made with the same engine with the swing truck blocked to represent a rigid truck without tender. The fourth trial was with the same engine swing truck blocked with tender.

Q. 125. On what day was that done?

A. That was done on the 19th of May.

Q. 126. Were these diagrams taken?

A. There was a diagram taken of each trial that day. We concluded four trials with engine 271 that day.

Q. 127. What was done on the succeeding day and with what engine?

A. On May 20th we commenced with passenger engine 652. We took the main connecting rods off the engine, the same as with engine 271. The engine being pushed ahead of the dynamometer car, trial No. 1 was made with the swing truck with tender; it ran the usual course around the Horseshoe Curve. For experiment No. 1½ we made a short trial between mile-post 242 and 243, including the Horseshoe Curve, having the swing truck with tender. For trial No. 2 we used the swing truck without tender, and ran over the full course from mile-post 240 to mile-post 243. For trial No. 3 we used the same engine, with the swing truck blocked to represent a rigid truck, with tender, and ran over the same course. For trial No. 4 we used the same engine, with a swing truck blocked with tender. Trial No. 4½ was made between mile-posts 242 and 243, making one mile trial, including the Horseshoe Curve, with the swing centre blocked, with tender.

Q. 128. Does that include all the trials?

A. That includes all the trials that were made at that time; there was a diagram taken on each trial.

Horizontal Scale 800' = 1 inch
Vertical " 80' = " "

Defuncts Epitaph
Alloria Grade
Rene N. L. L. L. L.
FROM PHILA. 240
Miles

FROM PHILA.



Inverclyde

KITSLANNING POINT.

Stone Arch Bridge - page 20

Hence She's Curie

Scene, Arch Bridge 29

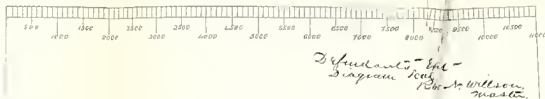
FROM PITTSBURGH
111 MILES

243
Mole 2 |

244
Milan.

FROM PHILA.





Defendants Exhibit -
Diagram Swing Centre Truck-Horse Shoe Curve
Robert A. Wilson
Master.



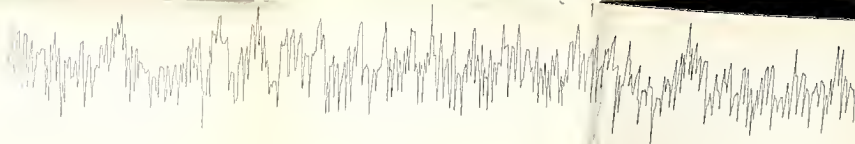
Each division of the Scale
measured perpendicular to the
datum line, represents one hundred
(100) pounds

Datum Line

Snow Cloud

Engine No. 652 with Swing Centre Truck.

Defendants Exhibit
Diagram Fixed Centre Truck-Horse Shoe Curve.
Robert A. Wilson
Master.



Datum Line

Engine 652 with truck centre blocked.

Snow Cloud

Q. 129. Have you examined the two diagrams marked: "Defendants' Exhibit, Swing Centre Truck, Horseshoe Curve," and "Defendants' Exhibit, Fixed Centre Truck, Horseshoe Curve," which you have designated as trials No. $1\frac{1}{2}$ and $4\frac{1}{2}$?

A. I have examined them.

Q. 130. What is the result of your examination of those two diagrams with engine 652, around the Horseshoe Curve, with swing centre and fixed trucks; give the average push first of the swing truck?

A. Trial No. $1\frac{1}{2}$ with the swing truck was twenty-six hundred and eighty (2680) pounds.

Q. 131. What was it with a rigid truck?

A. With the rigid truck trial No. $4\frac{1}{2}$ was twenty-six hundred and fifty-six (2656) pounds.

Q. 132. Which was a difference of—

A. Making a difference of twenty-four pounds in favor of the rigid truck.

Q. 133. Who were present on the 19th of May at Altoona when the experiments of which you have spoken were conducted?

A. There were present Mr. Hollingsworth; Mr. Moore; Mr. Strattan; Mr. Cloud; Mr. Willson, the Master; Mr. Whipple; Mr. Biddle; and myself.

Q. 134. Were those gentlemen on board the dynamometer car during the experiments on the 19th of May, or some of them?

A. They were all on the dynamometer car during some of the experiments on that day. I could not think that they were on all of them.

MR. BIDDLE: I offer in evidence:

"Defendants' Exhibit, Diagram Swing Centre Truck, Horseshoe Curve. Robert N. Willson, Master."

"Defendants' Exhibit, Diagram Fixed Centre Truck, Horseshoe Curve. Robert N. Willson, Master."

It is agreed that the following paper, prepared by Mr. Strattan, shall be offered in evidence as though testified to by Mr. Strattan.

Experiments made May 19th and 20th, 1876, with Dynamometer Car No. 2946, and Engines Nos. 272 and 652, pushing them up grade from Altoona to 111th mile-post, using Engine No. 149 for pusher.

	ENGINE No. 271.				ENGINE No. 652.			
	Swing Truck free.		Swing Truck blk'd.		Swing Truck free.		Swing Tr'k blk'd	
	1st Trip Engine and Tender.	2d Trip. Engine alone.	3d Trip. Engine alone.	4th Trip Engine and Tender.	1st Trip Engine and Tender.	2d Trip. Engine alone.	3d Trip. Engine alone.	4th Trip Engine and Tender.
Culvert, . . .	10- 9-30	11-55-00	3-19-50	5-20-40	10- 0-00	11-35-30	3-20-45	4-13-45
114th mile-post,	10-15-00	11-59-55	3-25-30	5-33-20	10- 7-40	11-41-27	3-27-12	4-20-20
113th mile-post,	10-17-20	12- 2-40	3-27-55	5-35-50	10- 9-42	11-43-18	3-29-05	4-22-18
112th mile-post,	10-19-48	{ 12- 4-25 12-10-10	{ 3-30-15 3-47-20	5-38-15	10-11-41	{ 11-45-00 11-57-10	3-30-55	4-24-15
111th mile-post,	10-22-20	12-12-10	3-49-40	5-40-40	10-13-43	11-59- 5	3-32-35	4-26-30
Ran 3 miles in	7m. 20s.	6m. 30s.	7m. 5s.	7m. 20s.	6m. 3s.	5m. 28s.	5m. 23s.	6m. 10s.
Miles per hour,	24.5	27.6	25.4	24.5	29.7	33.7	33.4	29.1

Where figures in brackets occur, there was a stop in the run, and both stopping and starting time are written.

After the first trip with engine 652, a run was made of one mile, from 112th to 111th mile-post, in two minutes and two seconds, as the engine was, with swing truck free; and after the fourth run, the same mile was run in one minute and fifty-eight seconds, with the swing truck blocked.

G. W. STRATTAN.

Adjourned until to-morrow, Wednesday, June 7th, 1876, at 10 A.M.

PHILADELPHIA, Wednesday, June 7th, 1876.

Parties met, pursuant to adjournment, at the office of the Master, Robert N. Willson, Esq., No. 216 South Fourth street, at 10 A.M. Present: S. S. Hollingsworth, Esq., H. B. Ren-

wiek, Esq., for complainants; Chapman Biddle, Esq., and S. M. Whipple, Esq., for defendant.

ISAAC DRIPPS CROSS-EXAMINED.

By MR. HOLLINGSWORTH:

† Question 135. Did you work out yourself all the results that you gave us of diagrams Nos. $1\frac{1}{2}$ and $4\frac{1}{2}$?

Answer. I did examine them.

† Q. 136. Did you work them out entirely yourself?

A. I did.

† Q. 137. Did anybody else work them out?

A. I think Mr. Cloud worked them out afterwards; either afterwards or before.

† Q. 138. Was your work in connection with Mr. Cloud, in any way?

A. We were in connection simply, and worked out afterwards. Our calculations I think agreed.

† Q. 139. They were not made together?

A. No, sir; made at separate times.

† Q. 140. They were made at separate times, and were entirely distinct, were they?

A. Yes, sir.

† Q. 141. Were the average lines which were drawn through those diagrams, from which the calculation was made, made at different times and distinctly?

A. Let me understand what lines you are alluding to. I did not make that irregular longitudinal line.

† Q. 142. You did not make this average line?

A. No, sir; I did not make the average line on either of those diagrams.

† Q. 143. Did you make any average line?

A. I made those longitudinal lines which you see there for the purpose of enabling me to decide the division of the points here, which enabled me to decide the average of the whole of the longitudinal, straight, horizontal lines. The diagram was originally divided into half-inch divisions. When I took hold of it,

I divided it into quarter-inch divisions. I divided each half inch into half, making quarter-inch divisions. I indicated the average by the points which you see marked on the diagrams. I would like to explain, if you will allow me, the reason why I made those parallel horizontal lines which you see there; it was to enable me to make a more accurate average of the whole, and then I divided it off into quarter divisions, as you see there, to enable me to make a more accurate average of the divisions, being so much shorter than the other.

† Q. 144. You do not know who made this line here, which I have called an average line; this broken, longitudinal line?

A. I do not.

† Q. 145. In these calculations which you have made from various diagrams of which you have spoken here, have you in all cases measured the distance horizontally between each up-stroke and the next down-stroke made by the pencil of the dynamometer?

A. I have.

† Q. 146. Do you mean to say that you have measured on every diagram of which you have spoken, and from which you have made a calculation, the horizontal distance between every up-stroke made by the pencil of the dynamometer and the next down-stroke made by the pencil of the dynamometer?

A. I measured the distance from the datum line to my average mark which you will find between each division. I have measured every division made by me on those diagrams.

† Q. 147. Do you mean to say that you have measured on every diagram of which you have spoken, and from which you have made a calculation, the horizontal distance between every up-stroke made by the pencil of the dynamometer and the next down-stroke made by the pencil of the dynamometer?

A. I did not measure the horizontal distance following the pencil marks, as is marked by the dynamometer between the different divisions, between the different vertical strokes, lines. But I measured the distance from the datum line up to the point that I supposed would be the average. I then took a pair of compasses and I adjusted them at that point, dividing equally

from what I should judge to be the extent of the pencil either way, either up or down, and from there I made the average point which you will find on all those diagrams that I have measured.

† Q. 148. You have spoken of certain calculation made by you in experiments Nos. $1\frac{1}{2}$ and $4\frac{1}{2}$, made from diagrams taken on May 20th, 1876, with engine 652; did you calculate the other diagrams made in the experiments had with that engine on that day?

A. You allude to the other diagrams made that day.

† Q. 149. Yes, sir.

A. I have not; they were handed to me to examine them, but I was so sick that I could not look at them.

† Q. 150. Did you calculate the diagrams made with experiments had with engine 271, on May 19th, 1876?

A. No; I have not examined them any further than— I will correct that. I have looked at them and I have examined them, but I could not go into a calculation on account of sickness; but from a comparison made of them with others I am satisfied they are correct.

† Q. 151. If you did not calculate the diagrams which were made on the 19th of May, what was the character of the examination which you did make of those diagrams which satisfied you without any calculation that they must have been correct?

A. I went over those diagrams, examined them carefully, and, from the work contained there, compared with the examination of former work done by Mr. Cloud on the experiments made prior to that, I saw nothing there but what would convince me that those experiments were correct, as correct as the others I had examined made by Mr. Cloud at the former time.

† Q. 152. Do you mean to say that by simply examining these diagrams of the work done on the 19th of May, by looking at them and comparing them with the diagrams had in a previous experiment, which had been worked out by Mr. Cloud, and which had also been worked out by yourself and found to be correct, that you could tell the correctness of the result reached by Mr. Cloud in working out the diagrams of the experiment of the 19th of May?

A. I say that on examining these experiments of the 19th of May I went over the diagrams and examined the figures, and also examined the result as given by the calculation of Mr. Cloud, and comparing the results of those calculations with the results made at a prior time, I saw that they were so little different when compared with the others, and I also found that in calculating the former experiment there was so little difference between Mr. Cloud and myself that I say to the best of my knowledge that these experiments are correct.

† Q. 153. You mean to say that if you had made the calculation you probably would not have differed from Mr. Cloud with reference to the 19th of May, to any greater extent than you had differed with him on the previous experiments, which were worked out by you and him, do you not?

A. I mean to say that in comparing the two experiments, one that I had calculated and one I had not, but had examined the diagram, by inspection and calculation of the two I came to the conclusion that the last experiments tried on the 19th and 20th of May were as correct as those tried on the former occasion, the difference in measurement between Mr. Cloud and myself would be very little, and not more than would be due to the different mode of measuring. Mr. Cloud measured by one way and I measured by another. Mr. Cloud measured by a scale divided into the one-hundredth part of an inch, and consequently he could calculate more accurately than I do, because he had a scale divided into finer fractions. I tried to measure it with a scale divided into the one-hundredth part of an inch, but my eyesight was not good enough, and therefore I had to resort to a scale which was exhibited here, but the result of the two calculations is very nearly the same.

† Q. 154. Then you did not measure, did you, the pencil marks on the diagrams which were had from the experiments made on the 19th and 20th of May, other than Nos. $1\frac{1}{2}$ and $4\frac{1}{2}$?

A. No, I did not; that is, I did not divide them. I did not know they were getting the average as I had with the former ones. I was not able to do so from sickness.

† Q. 155. You were on the front part of the engine when the

truck was blocked, were you not, during one part of the time of one of the experiments on the 19th of May?

A. Yes, sir.

† Q. 156. Did you notice any sideways motion in the truck?

A. I got on the engine when she was backing down, after the experiment was made, with several of the other gentlemen of the party. I think Mr. Moore was one of them, and he pointed out to me that there was some side motion to what we termed the solid truck. I did find, by examining closely, that there was a small perceptible motion, probably amounting to the one-eighth of an inch; certainly not more.

† Q. 157. When you examined the engine and found this slight lateral motion, it was immediately after the last experiment that day, was it not?

A. No, sir; I examined the engine after several of the experiments during the two days.

† Q. 158. When your attention was called to this lateral motion by Mr. Moore, it was immediately after the last experiment on the 19th of May, was it not?

A. I could not say as to what experiment it was without examining my book.

† Q. 159. When you noticed this vibration was the engine running fast or slow?

A. The engine was backing down, after we had completed the experiment around the curve there. We were going not at a very fast rate of speed, slower probably than when we were going up.

† Q. 160. It was just after the express train passed us going east, do you not remember?

A. No, sir; I do not remember.

† Q. 161. During these experiments, on the 19th of May, did you notice any irregularity in the rate with which the paper was fed to the registering machine part of the dynamometer?

A. I cannot correctly say that I noticed any difference in the speed of the paper, because it goes so slow that it would not be perceptible; but I did notice a difference in the speed of the shaft of the machinery that drove the paper, and this irregularity

was occasioned by a little play that there was between the shaft and the socket of the pipe it went into. There was a slight play there which at times would hold back and then go forward again, and so make a small irregularity in the motion of that part of the machine, not enough in my opinion to injure the results of the calculation by any means.

† Q. 162. Did you work out the diagrams in the experiment had on the Baltimore and Ohio Railroad on March 27th, and March 30th, of this year?

A. I worked out two of those diagrams. I cannot say which day it was unless I refer to my notes.

† Q. 163. I have no objection to your referring to your notes; look at them and tell me what day it was?

A. (Referring to notes.) I examined the diagrams of the experiments tried, on the 27th and 30th of March, but have only worked out the diagrams of the experiments tried on the 30th.

† Q. 164. How many experiments were tried on the 30th?

A. There were two experiments tried on the 30th.

† Q. 165. Were they both with the rigid truck?

A. Both with the rigid truck, the engine precisely the same.

† Q. 166. And those are the only diagrams you have worked out where the experiments were had in each case with the rigid truck?

A. The experiments in each case were with the rigid truck. The diagrams of the experiments on the 27th are so faint that I could not see them, and therefore I did not attempt to work them. The pencil marks on the diagram were so faint that I could not distinguish them so as to make an accurate measurement, and therefore I did not do it.

† Q. 167. Were those experiments on the 30th with the rigid truck; please state whether the drivers had all flanges on?

A. The two forward pairs of drivers had no flanges on; the hind drivers had flanges on.

† Q. 168. Do you know what the difference of the drivers was in the experiments on the 27th, when the truck was swinging?

A. During the experiment, the last experiment on the 27th,

the front pair of drivers had no flanges on; the other two, the middle and hind drivers had flanges on.

† Q. 169. Have you got the results of the diagrams you worked out of these experiments on the Baltimore and Ohio Railroad on the 30th of March?

A. In the first experiment No. 1, the pull was twenty-five hundred (2500) pounds, the last was twenty-four hundred and eighty-six (2486) pounds, making an average of the two of twenty-four hundred and ninety-three (2493) pounds.

Re-examined.

By MR. BIDDLE:

Q. 170. Is the one-eighth of an inch lateral motion, which you perceived on the 19th of May, 1876, in the blocked truck, after trial No. 3 was made, greater or less than the lateral motion usually obtained from a regularly constructed fixed truck under similar circumstances of road-bed and curve?

A. In practice we allow one-eighth of an inch, or about one-eighth of an inch play between the two centre castings in rigid trucks, and if you take any engine that has been in use for any length of time with a rigid truck, you will find fully one-eighth of an inch play, and frequently more.

Q. 171. Then the lateral motion which you perceived after trial No 3, with the blocked truck, is not greater than the lateral motion usually obtained from a regularly constructed fixed truck under like circumstances—is that so?

A. I can only answer that, as I did before, that if you take any engine with a fixed truck that has been used any length of time, you will find fully one-eighth of an inch, frequently more than one-eighth of an inch play, between the centre castings; so that the one-eighth of an inch is certainly not more than what is in general practice with rigid trucks.

Re-cross-examined.

By MR. HOLLINGSWORTH:

† Q. 172. Is there not the same play in the same centre cast-

ings in the swing truck as you have said is usual in practice with the fixed truck ?

A. I should suppose there is. I have never had any experience with the swing trucks, and they were never used on any road that I had charge of. With my knowledge of what it ought to be, I should say it would be about the same with the swing truck as with the other. I would also add that we must have a certain amount of play there. We cannot fit these castings tight. If we did, with the oscillation of the engine, they would break off what we call the lip of the lower casting ; and therefore we allow one-eighth of an inch, and frequently more play, to obviate that. Builders do not always turn their castings, but put them in rough, and in cases of that kind I have seen three-eighths of an inch play.

Signature of witness waived by consent of counsel.

JOHN W. CLOUD, recalled on behalf of defendants, is examined, and says :

By MR. BIDDLE :

Question 143. Were you present, at Altoona, on the 19th and 20th days of May, of this year, when the trials with engines 271 and 652 were made, and of which Mr. Dripps, the previous witness, has spoken ?

Answer. I was.

Q. 144. What, if any, was your duty or office in connection with those trials ?

A. My business was to attend to the recording apparatus, and see that the automatic diagrams were taken properly.

Q. 145. Did you superintend the taking of those diagrams in both the days referred to, the 19th and 20th ?

A. I performed the duty which I have mentioned, on both of those days.

Q. 146. Have you the diagrams which were taken during those several trials ?

A. I have.

Q. 147. Have you calculated the results of those diagrams, for the purpose of showing the force expended in pushing the engines referred to?

A. I have calculated them as nearly as I can calculate them.

Q. 148. And how have you done so?

A. I have done so by calculating them with a rule divided into one-one-hundredths of an inch, with the exception of the two short diagrams; that is No. 1 $\frac{1}{2}$ and No. 4 $\frac{1}{2}$, of May 20th.

Q. 149. Did you calculate the results of diagrams No. 1 $\frac{1}{2}$ and No. 4 $\frac{1}{2}$, and if so, how?

A. I calculated them with the scale which was produced here at the last examination; and which is an exhibit.

Q. 150. Give the results of the trials of May 19th, stating in your answer, whether the engines had the swing or free trucks, or the blocked or fixed trucks, and whether with tender or no tender; in other words, give fully all the conditions under which these several experiments were made, first with engine 271, on the 19th.

A. On May 19th, the first trial was with engine 271, with a swing truck and tender. The average which I obtained was from the diagram of the last two miles between mile-post 241 and mile-post 243 from Philadelphia, including the Horseshoe Curve. The diagram covers the whole of the distance from mile-post 240 to mile-post 243, but my calculation only covers the two miles. The average of this diagram which I used was $1\frac{822}{1000}$ of an inch, which is equivalent in pounds to 2531, and that is equivalent in foot pounds of work per mile to 13,363.680.

Q. 151. Have you the result of your calculation for the last mile or between mile-posts 242 and 243?

A. I have already stated that these two miles for which I give the average, were between mile-post 241 and 243.

Q. 152. Perhaps I do not make myself clear; did you work out the last mile between mile-posts 242 and 243 separately?

A. Yes, sir.

Q. 153. What is the result there?

A. I merely have a statement of the per cent. of difference which was this: It is the swing truck less than rigid, six-tenths

of one per cent. I did work it in pounds; but I have not the figures here with me.

Q. 154. You can produce them, can you not; you can work it over?

A. Certainly I can work it over. I have not had an opportunity to answer the question which you first asked me. I have been asked about what experiments were made on May 19th, and, if you will allow me I will go on and answer them:

The second experiment with engine 271, on May 19th, was made with a swing truck without a tender. The average ordinate was $1\frac{2.59}{1000}$ of an inch between mile-posts 240 and 243 from Philadelphia. This ordinate is equivalent in pounds to 1749, and that is equivalent to 9,234,720 foot-pounds of work per mile.

The third experiment, on the 19th of May, was with engine 271, with the truck blocked and no tender. The average ordinate which I obtained for the three miles between mile-posts 240 and 243, is $1\frac{2.30}{1000}$ of an inch, which is equivalent to 1708 pounds, and that is equivalent to 9,018,240 foot-pounds of work per mile.

The fourth experiment, on May 19th, with engine 271, had the truck blocked and with tender. The average ordinate was figured for the two miles between mile-posts 241 and 243 from Philadelphia, and is $1\frac{8.56}{1000}$ of an inch, which is equivalent in pounds to 2578, and in foot-pounds of work per mile to 13,611,840.

Q. 155. How does Experiment No. 1, with the swing truck and tender, compare with Trial No. 4 with the rigid truck and tender?

A. I have figured the percentages from the pounds of push and find that the swing truck less than the rigid truck in No. 1 and No. 4 respectively, is $1\frac{8.2}{1000}$ per cent.

Q. 156. Give us for the one mile the per cent. of difference between those two trials for one mile, between mile-posts 242 and 243?

A. The swing truck was less than the rigid, six-tenths of one per cent.

Q. 157. Now for the half mile between 242½ mile-post and

243, including the Horseshoe Curve; what was the percentage of difference?

A. It was rigid truck less than swing, six-tenths of one per cent.

Q. 158. Now the per cent. between trial No. 2, swing truck without tender, and trial No. 3, fixed truck without tender?

A. I have figured the percentage of difference similarly and find the swing truck more than rigid, two and four-tenths per cent. ($2\frac{4}{10}$).

Q. 159. Was this over the whole three miles?

A. Yes, sir; and was so stated in my previous answer.

Q. 160. Give us the results in pounds of the four trials on May 20th over the whole course?

A. On May 20th we experimented with engine 652, in a similar manner to the way we experimented with engine 271, on May 19th. The first trip was made with the truck swinging and with tender. The average ordinate which I have obtained by figuring for three miles between mile-posts 240 and 243 is $1\frac{6.53}{1000}$ of an inch, equivalent in pounds to 2296, and in foot-pounds of work per mile 12,122,880.

In the second experiment on May 20th, with engine 652, with the truck swinging and without tender, the average ordinate was figured for the last two miles only, and is $1\frac{2.34}{1000}$ of an inch, equivalent in pounds to 1714, and in foot-pounds of work per mile 9,049,920.

The third experiment was with engine 652, with the truck blocked and without tender, and was figured for the last two miles only, the average ordinate being $1\frac{2.5}{1000}$ of an inch, equivalent in pounds to 1701, and in foot-pounds of work per mile to 8,981,280.

Experiment No. 4, with engine 652, with the truck blocked with tender, figured for the whole three miles between mile-posts 240 and 243, gives an average ordinate of $1\frac{6.71}{1000}$ of an inch, equivalent in pounds to 2321, and in foot-pounds of work per mile, 12,245,880.

Q. 161. Please give the per cent. between trial No. 1 and trial No. 4, on the 20th of May?

A. Figuring from the pounds pushed, I find, from comparing Nos. 1 and 4, the swing truck less than the rigid truck, $1\frac{8}{100}$; and figuring Nos. 2 and 3 similarly, I find the swing truck more than the rigid seventy-six one-hundredths of one per cent.

Q. 162. Give the results of trials No. $1\frac{1}{2}$ and $4\frac{1}{2}$ with engine 652, over the Horseshoe Curve, on May 20th?

A. I scaled this diagram by the scale which is already on exhibit, and found the average push with the swing truck in No. $1\frac{1}{2}$ to be 2680 pounds; the average push with the rigid truck, which was No. $4\frac{1}{2}$, was 2656 pounds.

Q. 163. The per cent. between those two, or the difference, is what?

A. Is swing truck, more than rigid, nine-tenths of one per cent.

It is agreed that the following paper is to be put in evidence the same as if Mr. Cloud had testified to it:

Results of Experiments with Dynamometer Car, made May 19th and 20th, 1876.

Ex. No. 1, engine 271, swing truck with tender.
 Ex. No. 2, " 271, " " without tender.
 Ex. No. 3, " 271, rigid " " "
 Ex. No. 4, " 271, " " with "
 Ex. No. 1, " 652, swing " " "
 Ex. No. 2, " 652, " " without "
 Ex. No. 3, " 652, rigid " " "
 Ex. No. 4, " 652, " " with "

	Average ordinate.	Equivalent in pounds.	Foot-pounds of work per mile.	Remarks.
Ex. No. 1,	1.822''	2531,	13,363,680,	Last 2 miles.
Ex. No. 2,	1.259''	1749,	9,234,720,	3 "
Ex. No. 3,	1.230''	1708,	9,018,240,	3 "
Ex. No. 4,	1.856''	2578,	13,611,840,	Last 2 "
Ex. No. 1,	1.653''	2296,	12,122,880,	3 "
Ex. No. 2,	1.234''	1714,	9,049,920,	Last 2 "
Ex. No. 3,	1.225''	1701,	8,981,280,	" 2 "
Ex. No. 4,	1.671''	2321,	12,254,880,	3 "

Engine 271.

Trips 1 and 4, with tender, swing truck less than rigid, 1.82 per cent.*

Trips 2 and 3, without tender, swing truck more than rigid, 2.4 per cent.

Engine 652.

Trips 1 and 4, with tender, swing truck less than rigid, 1.08 per cent.

Trips 2 and 3, without tender, swing truck more than rigid, .76 per cent.

J. W. CLOUD.

Cross-examined.

By MR. HOLLINGSWORTH:

† Question 164. In making your calculations from all these diagrams, did you, in every case, measure the horizontal distance between each up-stroke of the pencil in the registering part of the dynamometer and the next down-stroke?

Answer. No, sir.

By THE MASTER:

† Q. 165. In your judgment, to arrive at an accurate result from each diagram of which you have spoken, is it necessary to measure the horizontal distance as well as the perpendicular?

A. It is impossible to measure it in all cases, and it is impossible to get a result entirely accurate. I do not claim that any of my figures are accurate, and I so stated in my previous testimony; but they are as nearly accurate as they can be figured, and I do not believe that they differ more than one per cent. from the true result which the dynamometer shows.

† Q. 166. Would it make your calculations as to results any more accurate, if you measured the horizontal distance?

A. I cannot conceive how you could help yourself at all by doing that: and Simpson's rule, which I used, does not intend that that shall be done, but that merely an average shall be arrived at as nearly as possible.

By MR. HOLLINGSWORTH:

† Q. 167. In experiments Nos. 2 and 3, made with engine

* On last mile, including Horseshoe Curve, swing truck less than rigid, with engine 271, with tender, $\frac{6}{10}$ of one per cent.

On last half mile, which is Horseshoe Curve, rigid truck less than swing, $\frac{6}{10}$ of one per cent.

652, on May 20th, you have told us that you calculated the diagram for two miles in each case only; which two miles were they?

A. As I stated in my testimony, they were the two miles between mile-posts 241 and 243, from Philadelphia, the last two miles of the course.

† Q. 168. Did you calculate the first mile in either of these experiments?

A. No, sir.

† Q. 169. Did you run the first mile?

A. We did.

† Q. 170. Why did not you make that calculation?

A. Because in one of those experiments we were flagged before entering the first mile, and, in going back to start, we did not go far enough to get our ordinary speed before passing the mile-post; and therefore we were storing momentum after that, and that made more work than it ought to have done, and made a greater amount of strain, and consequently it was not fair for comparison with the other diagrams, when we were running at a uniform speed.

† Q. 171. Was it your duty during that experiment to attend to anything except this registering part of the apparatus?

A. No, sir.

† Q. 172. How did you know, then, anything about it, until you calculated as to whether the momentum was sufficient or not?

A. I can tell, when I am riding on a train, whether we are running four miles or whether we are running twenty-four.

† Q. 173. Was the train running at twenty-four miles an hour when it entered on this course?

A. I do not know. I do not know what particular time you refer to. If you will specify any particular trip, I will give you a definite answer.

† Q. 174. With engine 652, upon experiment No. 2, on the 20th of May, was the engine going at a rate of four miles an hour or twenty-four?

A. I do not know.

† Q. 175. In experiment No. 3, did you know what speed the engine was going, when it entered the first mile?

A. I did not. I know in one of these trips it was going faster than the other.

† Q. 176. Have you any idea of the difference between the two?

A. Yes, sir; I have a general idea of the difference.

† Q. 177. About what was the difference of speed?

A. It was, I judge, somewhere between eight and twelve miles difference. I just judge that. I know there was a difference.

† Q. 178. Have you ever calculated any part of the tracings on the diagrams for either of these miles, the first mile in experiment No. 2 and 3?

A. I have not made an average.

† Q. 179. Have you ever calculated any part of the tracings?

A. No, sir.

† Q. 180. Did you measure the distance of the various points, what you call the datum line?

A. I did measure some of them.

† Q. 181. Why did you measure them?

A. It is from that, I get partially my idea of the subject.

† Q. 182. Then you were not correct when you said that the reason you did not make the calculations was because you judged from what you saw in the car that the speed was not so great?

A. Yes, sir; I was.

† Q. 183. Why then did you make the calculation?

A. I did not make a calculation; I made a measurement.

† Q. 184. Then already having had the idea which caused you not to make a calculation, you made the measurement in order to get the idea?

A. No, sir; I got my idea partially from that; but I got my idea from the two together. There were four experiments calculated for only two miles, two on the 19th and two on the 20th. In each case, that is, once on the 19th of May and once on the 20th we were flagged and did not get up to our normal speed before passing the mile-post. One day it was with the swing

truck, and one day it was with the rigid truck, so that on the day when the experiment was made with the swing truck the average was too high for comparison with the rigid truck ; and, again, on the day when the experiment was made with the rigid truck the average was too high for comparison with the swing truck ; and therefore that threw both experiments out as far as the first mile was concerned. I know exactly what I am explaining and that was the reason.

† Q. 185. Tell us the results of what you did measure of those two experiments ; how did they compare ?

A. I have not the figures, but the experiments, where we were flagged in each case, ran much higher in ordinates when we passed the mile-post, and for the first half mile, than the ordinates in the other experiments because we were making time and getting faster speed.

† Q. 186. I do not think you understand my question. I mean to say this : how did the push of the rigid compare with the push of the swing truck for as much of that mile in each experiment as you did calculate. I am referring to experiments Nos. 2 and 3 on May 20th ?

A. I have told you that I did not calculate any. I only measured some of the ordinates.

† Q. 187. So far as the results were reached, how did they compare ?

A. I have not the figures here. In one day the rigid truck ran very high because it was under the experiment with a rigid truck that we were flagged. The next day the swing truck ran up pretty high, something like an inch more than we should have had for an ordinate, because, on that day, we were flagged when we were using the swing truck, and therefore we threw out those two miles.

† Q. 188. You have already given us separately for this mile the per cent. between them on May 19th. You will remember that perhaps ?

A. No, sir ; I did not.

† Q. 189. Did you make any comparison of the average push with the swing truck, as compared with the rigid truck, upon the

first mile in the experiment of May 19th, in those cases where you have given us the result for two miles?

A. I did not make any comparison so far as calculating goes.

† Q. 190. Then what did you mean by saying that the percentage was six-tenths in the favor of the rigid truck?

A. That was on the last mile of the course, and there is where you misunderstood me.

† Q. 191. What comparison did you make?

A. I measured some of the ordinates.

† Q. 192. Did you measure any of the ordinates in the first mile of experiments Nos. 2 and 3, with engine 652, on the 20th of May?

A. I measured them all.

† Q. 193. Then you had the data from which you could calculate the push in pounds?

A. Yes, sir; it was down on the diagram, but I did not take it off.

† Q. 194. You had the data from which you could calculate the push in each case, in pounds?

A. Yes, sir.

† Q. 195. From them did you make any calculation at all; from those data?

A. No, sir; not for the first mile.

† Q. 196. From your comparison of the ordinates for that mile with those for the remaining two miles, on May 20th, with engine 652, was the push for that mile in favor of the rigid truck or in favor of the swing truck?

A. We were flagged when we were running with a swing truck, and the ordinates, therefore, ran higher, and were not fit for comparison with the rigid.

† Q. 197. You measured the ordinates for the first mile in experiments 2 and 3, with engine 652, on May 20th, did you not?

A. Yes, sir.

† Q. 198. From a comparison of those measurements, in favor of which engine would the push be?

A. We only had one engine.

† Q. 199. In favor of which truck would the push be?

A. I can only give you a judgment from looking at the figures. It was in favor of the rigid truck, and that was why it was thrown out, because there was too much difference.

† Q. 200. Was that the same cause which induced you to throw out the calculation on the 19th?

A. No, sir; there it was in favor of the swing truck, because we were flagged when we were using the swing truck.

† Q. 201. And the difference was so great that you threw it out?

A. Yes, sir; because we knew that it was not made under the same conditions.

Signature of witness waved by consent of counsel.

GEORGE W. STRATTAN, re-recalled on behalf of defendants, is examined and says:

By MR. BIDDLE:

Q. 57. Will you please refer to the defendants' printed proof, pages 27 and 28, showing the mileage of engines on the Baltimore and Ohio Railroad, and state the highest and lowest mileage of tires per sixteenth of an inch wear according to said exhibits?

A. Referring to these exhibits, I find that the highest mileage is in connection with engine No. 407, which is 25,558 miles per sixteenth of an inch wear. The lowest mileage is that of engine 400, on page 27 of defendants' proofs, which is 10,000 miles for a sixteenth of an inch wear.

Q. 58. Referring to those same exhibits, will you give us the average mileage of the twelve engines therein referred to, assuming that the tires were three inches thick when the engines were first put into service?

A. The average mileage of the twelve engines is 13,646 miles per sixteenth of an inch wear.

Q. 59. Have you made a comparison between the same class or description of engines, some using the swing truck and others using the rigid truck, as to the wearing of the tires of those classes of engines?

A. I have.

Q. 60. Where have you instituted that comparison; on what road?

A. The comparison was made of the engines running on the middle division of the Pennsylvania Railroad, which is from Harrisburg to Altoona.

Q. 61. Between how many engines have you made that comparison?

A. Eighteen engines.

Q. 62. How many of those had the fixed and how many the swing truck?

A. Nine of each.

Q. 63. What were the weights of those eighteen engines, severally?

A. I did not expect that question, and did not put down the weights. The average weight of that class of engines is 75,000 pounds.

Q. 64. Were the weights of those several engines about the same, respectively?

A. Yes, sir.

Q. 65. Did they perform the same kind of service?

A. They are engines of the same class and engaged in the same service.

Q. 66. Have you prepared a statement of the mileage of the engines of those two classes, showing the mileage of the tires to the sixteenth of an inch wear?

A. These engines are all of the same class. The only difference being that one has a rigid and the other a swing truck. I have the mileage.

Q. 67. Will you give us the mileage, first, of the swing trucks with a sixteenth of an inch wear of tire?

A. The statement I have prepared has not the mileage of each engine figured down per the sixteenth of an inch, but the average per the sixteenth of an inch of the nine engines with swing trucks is 15,961 miles.

Q. 68. Will you give us the same mileage for the sixteenth of an inch wear of tire with the rigid trucks?

A. The average mileage per sixteenth of an inch wear of nine engines with a rigid truck is 16,635 miles.

Q. 69. What is the difference then in favor of the rigid truck, so far as the wear of tires is concerned?

A. The average mileage is $4\frac{2}{100}$ per cent. less with the swing truck than with the rigid truck.

Q. 70. That is $4\frac{2}{100}$ difference in favor of the rigid truck?

A. Yes, sir.

Q. 71. Does the table which you have prepared exhibit any further results of comparison as to wear of tire between the rigid and the swing trucks?

A. No, sir.

Q. 72. How did you obtain the data from which you made the two statements in regard to the wear of tire on engines with the rigid and swing trucks?

A. These papers which I have in my hands, and which are signed by me, are copied from the records which I make of mileage and wear as the engines come in for repairs.

Q. 73. Where is that done?

A. Altoona.

The papers referred to by Mr. Strattan are agreed to be put in evidence the same as if he had testified concerning them, and are as follows:

PENNSYLVANIA RAILROAD COMPANY,
Office of Master Mechanic, Altoona Shops,
G. W. STRATTAN, Master Mechanic.

ALTOONA, PA., June, 1876.

Engine Number	Date tire was put in service.	Date of last turning.	Wear in sixteenths.	Mileage.
6,	June, '67,	Feb., '72,	9,	113,079
10,	Feb., '70,	Dec., '73,	6,	109,755
267,	April, '70,	Jan., '76,	12,	148,348
268,	April, '69,	May, '74,	8,	119,302
269,	July, '66,	Feb., '75,	14,	253,681
270,	Sept., '70,	Oct., '75,	10,	169,893
308,	Nov., '68,	Dec., '75,	8½,	173,191
372,	Aug., '68,	July, '71,	9,	141,120
384,	Dec., '66,	Aug., '71,	7,	160,615
Total,			83.5	1,388,994
Average mileage per sixteenth,				16,635

Engines with rigid truck on *Middle Division*.

G. W. STRATTAN.

PENNSYLVANIA RAILROAD COMPANY,
Office of Master Mechanic, Altoona Shops,
G. W. STRATTAN, Master Mechanic.

ALTOONA, PA., June, 1876.

Engine Number	Date tire was put in service.	Date of last turning.	Wear in sixteenths.	Mileage
102,	Aug., '70,	March, '73,	4,	31,596
105,	Dec., '67,	July, '75,	13,	137,477
109,	Sept., '69,	April, '74,	6½,	112,003
266,	May, '69,	April, '74,	8½,	126,801
271,	Sept., '70,	Feb., '74,	6,	118,321
303,	March, '69,	March, '76,	9,	183,340
307,	March, '69,	May, '74,	6,	111,653
344,	Jan., '73,	Feb., '76,	6,	113,854
371,	Sept., '66,	Dec., '72,	10½,	164,305
Total,			69.5	1,109,350
Average milcage per sixteenth,				15,961

Engines with swing truck on *Middle Division*.

Average milcage is $4\frac{22}{100}$ per cent. less than that with rigid truck.

G. W. STRATTAN.

Q. 74. Do you know the number of engines having the swing truck which are in use on the Pennsylvania Railroad, on the Philadelphia and Erie Railroad, and what has been heretofore known as the United Railroads of New Jersey Division?

A. Three hundred and eleven engines with rigid trucks, and six hundred and twenty-four with swing trucks.

Q. 75. How many years has the Pennsylvania Railroad Company used swing trucks on their engines?

A. I judge about ten years.

Q. 76. What is the average time that the six hundred and twenty-four engines with the swing trucks have been in use on the Pennsylvania Railroad?

A. I cannot give you the necessary figures from the date at which each swing truck was put in service; but I think the average would be four and a half or five years.

Q. 77. Referring to printed page 57 of defendants' proofs, showing the cost of construction and of maintainance of swing

centre attachments, what additional sum, if any, has it cost the Pennsylvania Railroad to construct swing trucks for six hundred and twenty-four engines?

A. According to the statement on page 57, the difference in the cost in the construction of the swing truck above the fixed centre truck is twenty-eight and $\frac{78}{100}$ dollars (\$28.78), and for six hundred and twenty-four engines, it would amount to seventeen thousand nine hundred and fifty-eight and $\frac{75}{100}$ dollars (\$17,958.75).

Q. 78. What would it cost to maintain these six hundred and twenty-four engines with the swing centre trucks for a period of five years?

A. On page 57 the cost of maintenance is given at nine and $\frac{52}{100}$ dollars (\$9.52); for a period of five years, six hundred and twenty-four engines would amount to twenty-nine thousand seven hundred and two and $\frac{0}{100}$ dollars (\$29,702.40).

Q. 79. What would be the total cost of construction and maintenance as already testified by you for those six hundred and twenty-four engines for a period of five years?

A. That would be forty-seven thousand six hundred and eleven and $\frac{12}{100}$ dollars (\$47,611.12).

Cross-examined.

By MR. HOLLINGSWORTH:

† Q. 80. In what way did you select these engines which you compared?

A. We took eighteen engines of the same build engaged in the same work, half of them having the fixed centre and the other half having the swing centre.

† Q. 81. Have you records of any others than those of the same build used in the same work, some of which are swing and some of which are fixed centres?

A. Yes, sir.

† Q. 82. Do you know how they compare?

A. No, sir.

† Q. 83. How many more are there which you could compare in that way?

A. I think there are few. Our difficulty was in getting enough engines that could be compared; that is, engines of the same class, engaged in the same service.

† Q. 84. Had the rigid truck engines used in this comparison any flanges on the forward driving-wheels?

A. Neither the rigid truck nor the swing centre truck engines had flanges on the front pair of drivers. These engines were all ten-wheeled engines, with three pairs of drivers.

† Q. 85. Did the rigid truck engines which you used have any flanges on the middle pair of drivers?

A. The engines were all alike. The middle pair and the back pair had flanges on them.

Signature of deponent waived by consent of counsel.

Adjourned until this afternoon at 2 o'clock.

AFTERNOON SESSION.

WALTER MCQUEEN, a witness produced on behalf of the defendants, is sworn by the uplifted hand, examined, and says :

By MR. BIDDLE:

Q. 1. Where do you reside?

A. Schenectady.

Q. 2. What is your age?

A. 58. Fifty-eight.

Q. 3. What is your business?

A. I am in no business just now.

Q. 4. What was your business?

A. Locomotive building.

Q. 5. Where did you carry it on?

A. In Schenectady.

Q. 6. In any works there?

A. Yes, sir; the Schenectady Locomotive Works.

Q. 7. What was your position in the Schenectady Locomotive Works?

A. Superintendent of the works.

Q. 8. And how long were you the superintendent of those works?

A. Over twenty-four years.

Q. 9. During those twenty-four years have you been in any wise interested in the company of the defendants; that is, the Pennsylvania Railroad Company?

A. No, sir.

Q. 10. Has the Schenectady Locomotive Works during these twenty-four years built locomotive engines with the rigid and with the swing centre trucks?

A. Yes, sir; we have built both kinds.

Q. 11. About how many have you built during that period?

A. Over a thousand of both kinds.

Q. 12. Of that thousand, how many were swing trucks?

A. I cannot say exactly.

Q. 13. As nearly as you can?

A. Well, I could not say, very near.

Q. 14. Give us an idea?

A. I should say from fifty to seventy-five. Mr. Moore who is the secretary and agent of the complainant's company probably knows better than I do about the exact number. He has the figures, and I have not.

Q. 15. Why does he know better than you?

A. We have had to pay for the royalty for all the engines that we built with a swing truck.

Q. 16. Do you recollect when you first put a swing truck under a locomotive engine at your works?

A. In the winter of 1860.

Q. 17. Under what circumstances did you put that swing truck under a locomotive engine?

A. The first we put under we built for Alba F. Smith of the Hudson River Railroad.

Q. 18. Was that Alba F. Smith afterwards the patentee of this swing truck?

A. I believe he was. That is the understanding I have of the matter.

Q. 19. Did you put his swing truck under more than one engine, about the year 1860, and if so, how many?

A. Under about two; two that we built for Mr. Smith that year.

Q. 20. Do you know where those engines were used; on what road?

A. They were used on the Hudson River Railroad.

Q. 21. Did you build any more engines shortly after with the swing truck?

A. We did, in 1861, build some others.

Q. 22. How many?

A. We built four for the New York Central Railroad Company.

Q. 23. Where were they put on the road; what parts of the New York Central Railroad?

A. There was one put on each division of the New York Central Railroad.

Q. 24. Do you know whether they were approved by the master mechanics of those divisions or not?

A. Yes, sir.

Q. 25. Were they approved?

A. They were not.

Q. 26. On page 29 of the complainant's testimony, the witness, Gardiner C. Simms, in answer to Question 27, speaks of engine No. 9 which was in use on the New York Central Railroad, as having a swing truck; do you know what kind of an engine No. 9 is?

A. Yes, sir; what is called a Mogul engine; it is an engine with six drivers and a pony swing truck, a two-wheeled truck.

Q. 27. How does the power of that class of engines compare with their weight, the weight being given on page 30 of complainant's proofs as sixty-five thousand five hundred (65,500) pounds?

A. I should state it was very heavy for the power, having a cylinder 15 x 22.

Q. 28. Look at the photograph on page 74 of the illustrated catalogue of Baldwin's Locomotive Works, and say whether that substantially represents a Mogul engine such as you have spoken of?

A. In the disposition of the wheels, that is substantially the same as engine No. 9 on the New York Central Railroad; it is a little different in the boiler and other parts.

Q. 29. Do the two pony wheels correspond with what is known as the swing truck, and if not, why not?

A. I do not know any more than in the name. One has two wheels and the other four. They are both substantially swing trucks.

Q. 30. What is known as a swing truck has four wheels?

A. Yes, sir.

Q. 31. Now the pony wheels are made to rotate around a centre pin and are made to vibrate in the boxes, are they not, in either mode?

A. Yes, sir; they can be made in either way, I suppose.

Q. 32. The truck having the two pony wheels, such as in engine No. 9, is not like the truck which is used under the patent of Alba F. Smith, is it?

A. No; it is not much like that; it has the same swing arrangement.

Q. 33. Is not the truck with the two pony wheels a truck that is used under the patent known as Hudson's patent, which is of a subsequent date to the Alba F. Smith patent?

A. That is something I do not know anything about. That is the general opinion of people, and that is what is understood amongst them that it belongs to Mr. Hudson. I have always understood so.

Q. 34. What are the Mogul engines on the New York Central chiefly used for?

A. They are used for helping engines; switching engines, and occasionally they run on the road when an engine breaks down and there is a press of business.

Q. 35. Mr. Simms, on printed page 30 of the complainant's evidence, in answer to Cross-question No. 38, says there are

about twelve engines between Albany and Utica, out of four hundred and fifty engines, which have the swing truck. What is the character of those twelve engines; are they also Mogul engines, or not?

A. They are all Mogul engines, I believe. I believe they have not an eight-wheeled engine, nor any four-wheeled trucks with any swing attachment on the road.

Q. 36. Mr. Simms, in answer to Cross-questions 52 and 53, said that the reason why there was so small a proportion of swinging trucks in use on the division between Albany and Utica, was, that Commodore Vanderbilt said he would see a man in hell before he would pay him royalty; do you know whether that answer is correct or not?

A. I know that the master mechanics of the New York Central Railroad, or the four master mechanics that there were at that time in 1861, when these swing trucks were put on, did not approve of the swing truck, three years before Commodore Vanderbilt was interested, or had a heavy interest in, or took charge of the management of the New York Central Railroad. I believe Commodore Vanderbilt got control of that in 1862 or 1863—that is not three years; it is about a year after the time I speak of.

Q. 37. What sort of an engine is engine 41 referred to by Mr. Simms, in his testimony, in answer to Question No. 30? The question asked him was: Q. "Take Exhibit No. 4, and tell us what that is?" "A. Engine No. 41. The mileage is 40,949 miles. It has a centre-bearing truck. The wear is illustrated in the same manner. The original line is placed on there. It gives the wear of the flange and the wear of the tread. The distance between the lines represents the wear."

A. That is a usual eight-wheeled engine with a rigid truck.

Q. 38. Is it such as photographed on page 56 of the illustrated catalogue of Baldwin's Locomotive Works?

A. Yes, sir; that is substantially the same design and arrangement of the wheels.

Q. 39. Then engine 41 has four wheels and a fixed truck, has it not?

A. Yes, sir.

Q. 40. Do you know what service engine 41 was employed to perform?

A. No; I do not know anything about that.

Q. 41. Do you know about the size of the cylinder of engine 41?

A. Well, I am not positive about it. It is my impression that it was a sixteen-inch cylinder 16 x 24, but I am not positive.

Q. 42. Which engine, No. 9 or No. 41, would slip its wheels on the track most?

A. I should say No. 41.

Q. 43. Why?

A. Being a much lighter engine, and taking more weight on the truck than the other engine, and not having so much weight on the drivers.

Q. 44. As you have been connected for about twenty-four years in superintending the construction of locomotives, can you give us the extra cost of fitting an engine with a swing truck?

A. Well, we have never figured it down to know exactly what it is; but I should say from fifty (\$50) to one hundred dollars (\$100), the way we usually put it under.

Q. 45. Then, as I understand you, it would cost to build an engine with a swing truck attachment from fifty (\$50) to one hundred dollars (\$100) more than it would cost to build a similar engine with a fixed or rigid truck?

A. Yes, sir; building in the manner that we have been in the habit of building them. We have got into a cheaper way of building them lately. We have followed our neighbors instead of following our own ideas of how things should be.

Q. 46. What does it cost then, in the cheaper way which your neighbors have resorted to?

A. It would cost twenty-five (\$25) or thirty dollars (\$30) I suppose.

Q. 47. Which, in your opinion, is the better truck for railroad service; the swing or the fixed?

A. Well, I think that is a question that should be determined by the master mechanics; every man for himself. My opinion

about that, not having had the experience because I was not on the road, might not be worth much. If I had been on the road I would give my experience, for that is a matter that could be learned by experience; but my own impression is that I would not make any difference between the two. I would as soon have one as the other, but I may be mistaken.

Q. 48. Is there any difference in mounting the swing and the fixed truck, so far as the centre plates are concerned?

A. That is where the upper plate rests inside the bottom plate.

Q. 49. Yes, sir.

A. No; they are substantially the same; they are the same exactly.

Q. 50. Is there any play allowed either to the swing or to the fixed truck, or to both?

A. Some men allow more than others. They generally allow from about one-sixteenth to three-eighths of an inch play. Perhaps we fit them up snugger than any one else; we turn them, but the most of the builders and master mechanics cast them and do not turn them, and they allow one-sixteenth to three-eighths of an inch play.

Q. 51. Then your answer refers to both swing and fixed trucks?

A. To both the same.

Q. 52. Have you built recently any engines for the Central Pacific Railroad Company?

A. We have.

Q. 53. And how were those built; I mean with reference to the truck; had they the swing or the fixed centre?

A. They were ten-wheeled engines with a rigid truck.

Q. 54. Do you build any swing trucks, unless to order?

A. No, sir; we do not.

Cross-examined.

By MR. HOLLINGSWORTH.

† Q. 55. Did you ever build any engines for the Cazenovia and Canastota Railroad Company?

A. Yes, sir.

† Q. 56. How many did you build?

A. Two.

† Q. 57. Did these engines give satisfaction?

A. Yes, sir.

† Q. 58. Were you ever called upon to alter them in any way?

A. They had them altered and we were paid for it.

† Q. 59. Will you be kind enough to state whether the alteration related to trucks?

A. We sent them out with the rigid truck and they altered them to a swing truck?

† Q. 60. Why?

A. It was their wish to have them so.

† Q. 61. Do you know the reason they assigned?

A. No; I do not know what the reason was. I believe the reason which the manager of the road gave me was that Mr. Alba F. Smith had persuaded them that it would be a great benefit to the road to have them so.

† Q. 62. Did you ever hear them say that they did not work as well with the rigid truck as they did with a swing?

A. They thought they would work a great deal better if they had a swing truck under them, and we made it for them, and it is my impression they considered after they got the swing truck that it worked better and that they were well satisfied with the expense they put on them. Whatever it was they paid us for it.

† Q. 63. You say that in 1861 some four of the master mechanics of the New York Central Railroad were dissatisfied with the swing truck upon the four engines they had there?

A. Yes, sir.

† Q. 64. Were not other swing truck engines subsequently introduced on that road?

A. I think not, except Moguls. You cannot run a Mogul engine without a swing truck, or its equivalent, in end play to the forward axles.

† Q. 65. Several of these Mogul engines were used there subsequently to 1861, were they not?

A. Yes, sir; they were built, I guess, in 1864, 1865, and 1866.

I guess there was not any built in 1865; but rather later than that.

† Q. 66. Can you tell me the number of engines with a rigid truck that you have built since 1861?

A. No; I cannot give you the number.

† Q. 67. Roughly. You gave us one thousand as the number for the whole twenty-four years, and you did not commence to build swing centre trucks until 1861. How many engines, approximately, have you built since?

A. I should say between six and seven hundred, probably six hundred.

† Q. 68. I call your attention to page 56 of the illustrated catalogue of Baldwin's Locomotive Works, and ask you whether the engine on that page is not an engine having a four-wheeled truck centre bearing, swing bolster.

A. I cannot see anything there to tell me.

† Q. 69. Then when you say that the engine is similar to engine No. 41 on the New York Central Railroad, you do not have reference at all to the truck, whether swing or rigid?

A. No, sir; it is the arrangement of the wheels.

† Q. 70. Can you use a longer driving-wheel base with a swing truck than you can with a rigid truck?

A. I think not; I do not see how you can.

† Q. 71. Does the use of the swing truck facilitate the engine in any respect in going around a curve?

A. Well, that is a pretty hard question to answer. One man might have an opinion one way, and another man another; and both opinions might be sound.

† Q. 72. I am asking you for your opinion?

A. My opinion is that there is no difference, and that one engine properly constructed and arranged will swing just as well as the other, around a curve.

† Q. 73. Why did they put a swing truck under these Mogul engines on the New York Central Road?

A. Why did they do so?

† Q. 74. What was the object in so doing?

A. It was to have that end play to carry the weight to the

forward part of the engine. There was not enough weight put upon the drivers, and therefore this end play had to be provided for; but the engine would run better with the wheels out than with the wheels under.

† Q. 75. Could not the weight be carried just as well without any end play?

A. The end play is necessary going around a curve, because without it you could not go around a curve at all; but on a straight track the weight would carry just as well without the end play.

† Q. 76. Why would the weight not carry just as well around a curve as in the end play or swing truck?

A. The ordinary truck would carry around, but the ordinary four-wheeled truck conforms to the track.

† Q. 77. Why would not these two-wheeled trucks do it just as well?

A. It would; and end play would do just the same.

† Q. 78. My question is, why it would not do just as well, in going around a curve, without any end play or swing motion, as with it?

A. It would make too long a wheel base.

† Q. 79. What do you mean by having a longer wheel base; do you mean that it would have difficulty in going around a curve?

A. Yes, sir; it would be harder to go around a curve on the track.

† Q. 80. Is the wear of the flanges or drivers greater with a swing or a fixed truck?

A. I do not think there is any difference, if you get the truck exactly in the centre, and the engine square with the axles.

† Q. 81. Suppose it is not exactly plumb, what then?

A. If it is not exactly square, the swing truck will have a little the best of it, because it will adjust itself naturally to the centre, and that would make a recompense for bad workmanship. There is no necessity of having them that way except bad workmanship.

† Q. 82. You have stated in your examination in chief, that

these four engines used on the New York Central Railroad were not approved by that road, and that you knew they were not approved. That knowledge was derived, was it not, from what the master mechanics told you?

A. They wrote to us about it. Mr. Smith was a particular friend of mine, and I took the responsibility as superintendent of the works to go to the expense of putting these trucks under the four engines, purely from friendship to Mr. Smith. I sent the master mechanics word when I sent the engines. We had a large order from them at that time, and I intended to put the swing truck under all the engines if they approved of it, and I asked them to write to me on that subject. They did not approve of the truck, and they wrote back that they did not like it, and did not want any more swing trucks under the engines.

† Q. 83. How soon was that after the trucks were put in?

A. As soon as they were in I wrote to the master mechanics; and they wrote back as soon as they decided the matter; a month or two months perhaps.

Signature of deponent waived by consent of counsel.

WILLIAM H. SMITH, a witness produced on behalf of defendants, is sworn by the uplifted hand, examined, and says:

By MR. BIDDLE:

Q. 1. Where do you reside?

A. New York City.

Q. 2. How old are you?

A. Thirty-nine.

Q. 3. What is your business?

A. Well, I am now Superintendent of the Empire Vacuum Brake Company.

Q. 4. Why was your business before you were engaged with the Empire Vacuum Brake Company?

A. I was general foreman of the Hudson River Railroad, New York Division.

Q. 5. Whereabouts?

A. At New York City.

Q. 6. Under whom were you?

A. Under Mr. William Buchanan.

Q. 7. About how long were you on the Hudson River Road?

A. I was sixteen and a half years in their employ, and I was twelve years foreman.

Q. 8. As such foreman, have you any knowledge of the Alba F. Smith swing truck?

A. Yes, sir.

Q. 9. How far does your knowledge date back?

A. 1858.

Q. 10. Was that about the first experiment with the Smith truck?

A. The first engine with the Smith truck was just finished when I went in their employ.

Q. 11. And it extended down to what month and year, when you left?

A. September, 1875.

Q. 12. Do you know how many engines, during the course of your service with the Hudson River Road, had swing trucks?

A. About sixty.

Q. 13. And how many of those remain at this day in service, or rather how many swing truck engines were in service, when you left, on the Hudson River Road?

A. I should say about eight or ten.

Q. 14. And then all these fifty engines which had at one time the swing truck have they been altered, and if so, how?

A. They have been altered. Some of them I blocked by putting a piece of angle iron on the outside of the castings so as to hold the truck rigid. In others I took the castings out entirely and bolted a new casting between the upright beams in order to make them rigid.

Q. 15. Then those engines that had at one time the swing truck have become now engines with rigid trucks?

A. Yes, sir.

Q. 16. Why did you change from the swing to the rigid trucks?

A. From the fact that the swing centre truck would not stay in the proper position. It would get over and cause the engine to track badly and wear the flanges on the tires.

Q. 17. The effect of that departure from the centre is to cause the tires to wear unduly, is it not?

A. Yes, sir.

Q. 18. Do you know what the extra cost of constructing a locomotive with a swing truck is?

A. Well, the way we used to construct them I used to estimate it at about twenty-five or thirty dollars.

Q. 19. What is the cost of maintaining an engine with a swing truck per annum?

A. I should say from twelve to fifteen dollars.

By THE MASTER:

Q. 20. Do you mean the cost of maintaining a swing truck over and above the cost of maintaining a fixed truck?

A. Yes, sir.

By MR. BIDDLE:

Q. 21. What advantages, if any, does a railroad derive from the use of a swing truck over a rigid truck?

A. I do not see any; I should say it was rather a detriment.

Cross-examined.

By MR. HOLLINGSWORTH:

† Q. 22. Does it require more power to take a swing truck around a curve than it does to take a rigid truck?

A. I am not prepared to answer that question.

† Q. 23. Do you know anything about it?

A. No, sir.

† Q. 24. Which way will the engine go around the curve the easiest, with the drivers radial to the track or corner to it?

A. Of course if the wheels are not in line and running parallel to the rail they cannot be expected to go around easy.

† Q. 25. I want to know which way the engine will go around a curve the easiest, whether it will go easiest when the axles of the drivers are radial or corner to the track?

A. I think my answer answers that.

† Q. 26. Just answer it again then?

A. I said of course you cannot expect a wheel to go around easy unless it is running parallel to the track or words to that effect.

† Q. 27. Then I understand you to mean that it does go easiest when the wheels are radial to the curve?

A. Most decidedly.

† Q. 28. Do you know whether that position is best attained with a rigid or a swing truck?

A. I could not say positively.

Signature of deponent waived by consent of counsel.

WILLIAM F. BEARDSLEY, a witness produced on behalf of defendants, is sworn by the uplifted hand, examined, and says:

By MR. BIDDLE:

Q. 1. Where do you reside?

A. At Sunbury.

Q. 2. What is your business?

A. Master mechanic of the shops of the Philadelphia and Erie Railroad.

Q. 3. What is your age?

A. Twenty-nine.

Q. 4. How long have you been such master mechanic?

A. About sixteen months.

Q. 5. What were you before that time?

A. I was draughtsman at Renovo for the same road.

Q. 6. Of what division on the Philadelphia and Erie Road are you a master mechanic?

A. Of the eastern division.

Q. 7. How far does that extend from Sunbury?

A. It extends from Sunbury to Renovo, a distance of ninety-five miles and a little over.

Q. 8. Have you on that division in use any of the swing trucks?

A. Yes, sir.

Q. 9. Have you changed any of those swing trucks into the rigid trucks?

A. We have.

Q. 10. When?

A. I cannot give you any particular date.

Q. 11. I mean generally; I do not care for the particular month or day, but in what year?

A. We have changed some in 1875; but back of that I cannot say, as I was not there.

Q. 12. Why did you make the change from the swing to the rigid truck?

A. The centres of the swinging trucks did not appear to stay in their proper position.

Q. 13. How did you convert the swing into the fixed truck?

A. By putting braces on each side of the swinging centre and bolting them there.

Q. 14. Was the effect of these bolting braces to make the swing truck a rigid or fixed truck?

A. It was.

Q. 15. Absolutely?

A. Yes, sir.

Q. 16. Did you observe any difference in the working of the engines with a swing truck and the engines with a fixed truck?

A. There was this difference to my personal knowledge. When this swing centre did not stay in its proper position the engine would, as we call it, go to one side and cut the flanges of the tire. As soon as we made them stationary or rigid, it kept the engine in proper position and the tire did not cut.

Q. 17. How did the performance of those engines which you converted from a swing into a rigid truck compare when rigid with those engines when swinging?

A. My previous answer would include that. The flanges of

the tire did not cut so much as when the swinging centre was under the truck.

Cross-examined.

By MR. HOLLINGSWORTH :

† Q. 18. Where did you get these swing trucks which you altered?

A. The most of them came from the Baldwin Locomotive Works.

† Q. 19. Will an engine go around a curve easier when the axles of the drivers are radial to the curve or when they are not?

A. When they are radial to the curve.

† Q. 20. Which kind of a truck leaves the axles of the drivers radial to the curve, the swing or the fixed?

A. I do not know that there is any difference in the two trucks.

† Q. 21. In your opinion there is no difference between the two trucks in that respect?

A. That is all.

Signature of deponent waived by consent of counsel.

Adjourned to meet at the call of the Master.

